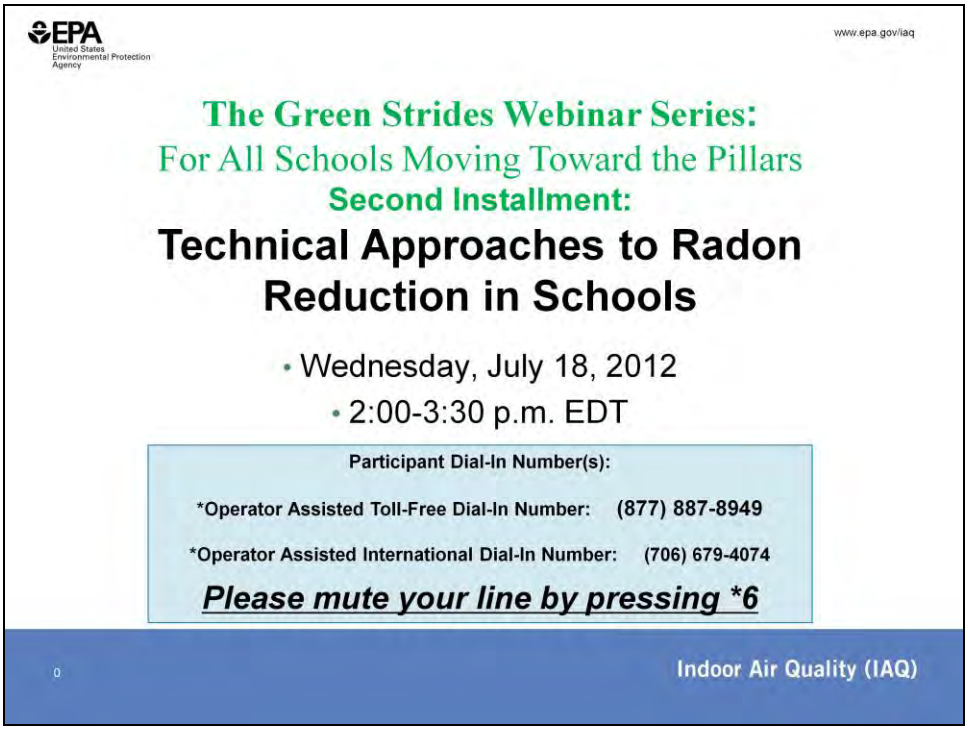
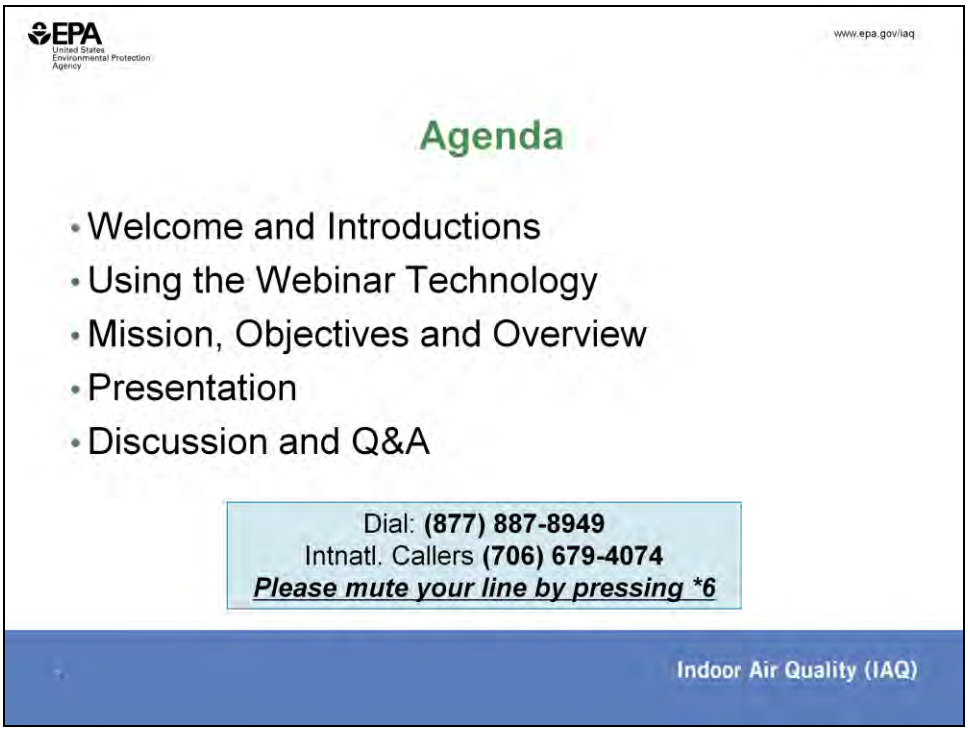


Lou Witt:

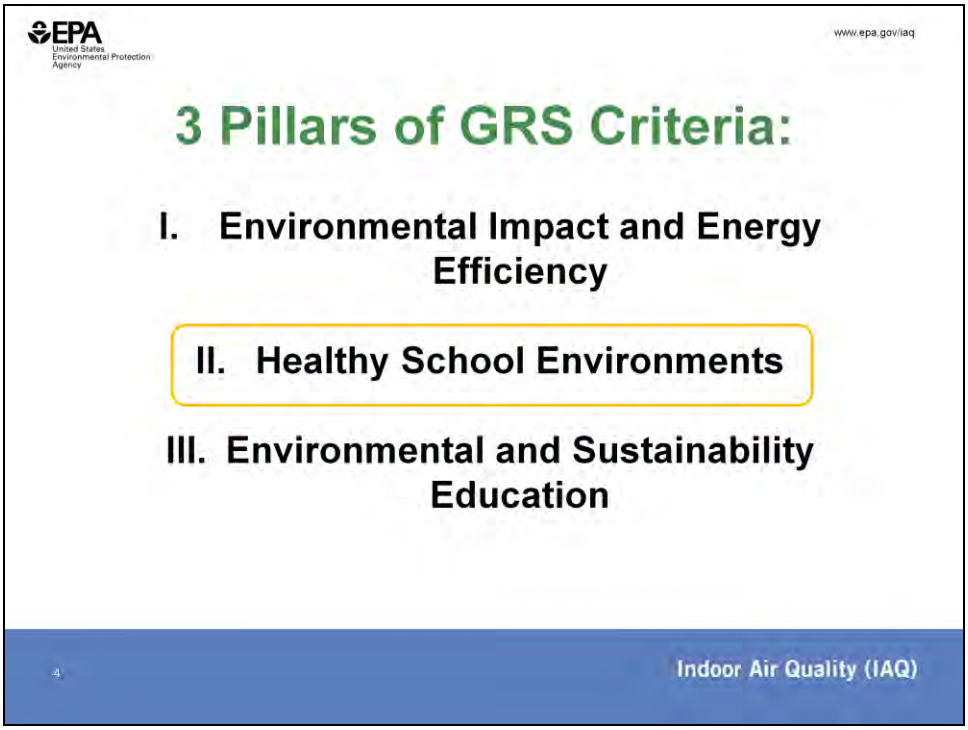
Good afternoon. This is Lou Witt with EPA's Indoor Environments Division and welcome to the Green Strides Webinar Series for Schools Moving Toward the Future.



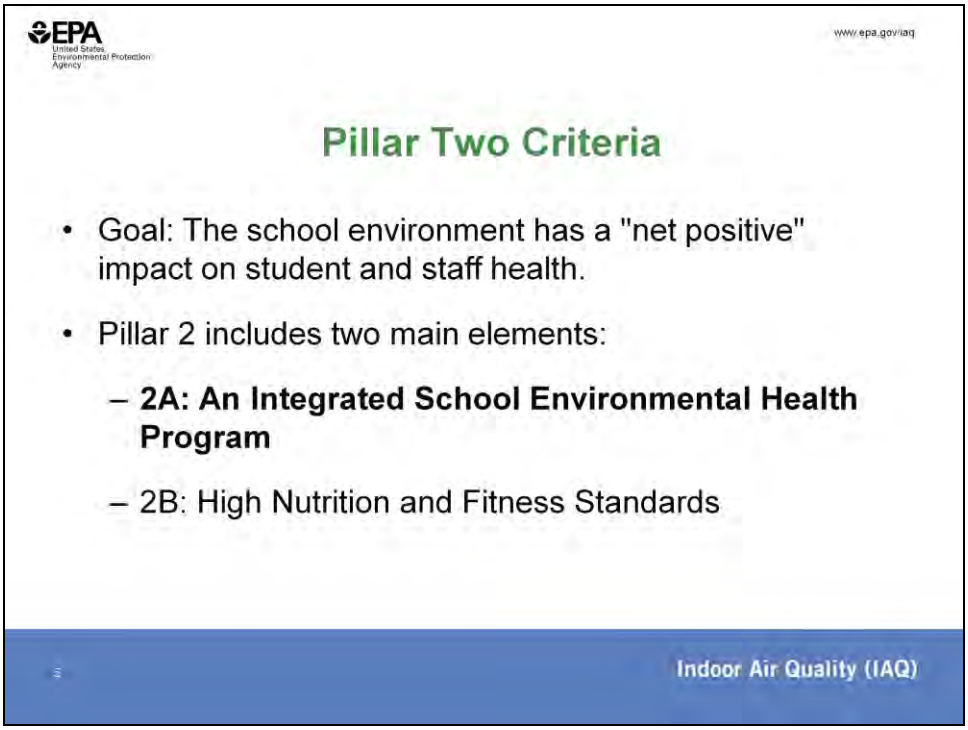
Our second installment today is the technical approaches to radon reduction in schools.

And we're very fortunate to have Jani Palmer, our EPA scientist, and two building experts and research scientists from the Department of Health from the State of Minnesota.

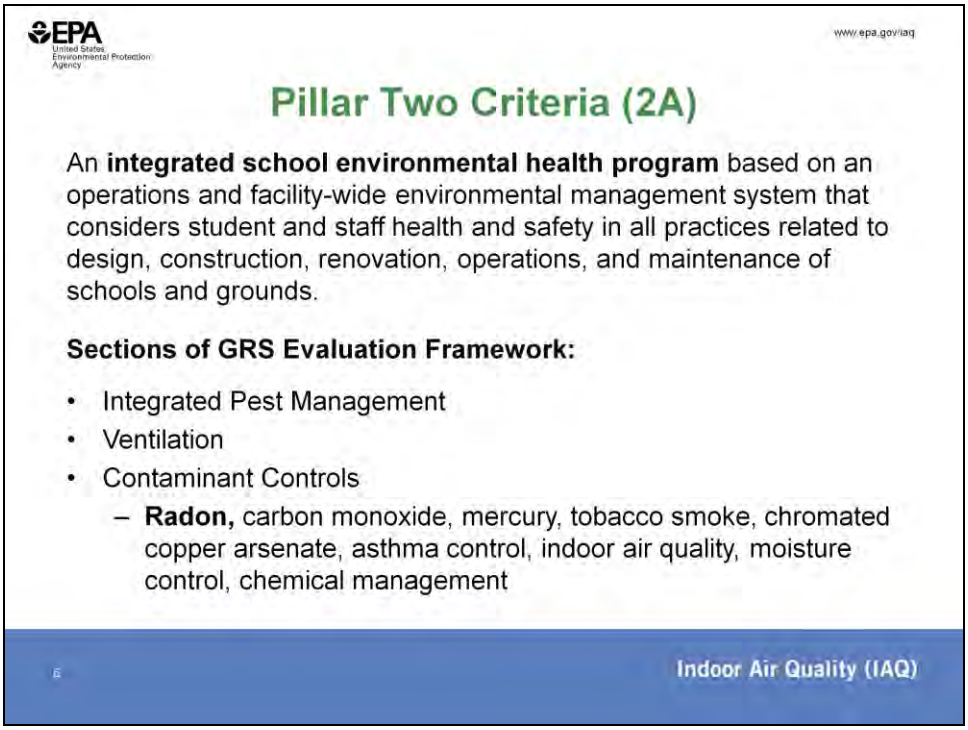
As I've said earlier, my name is Lou Witt. I'm with the EPA's Indoor Environments Division and as any good bureaucracy, we have a mission statement. Our mission is to protect the public's health from indoor environmental concerns where they live, learn, work and play. In other words, we're after healthier buildings and healthier people.



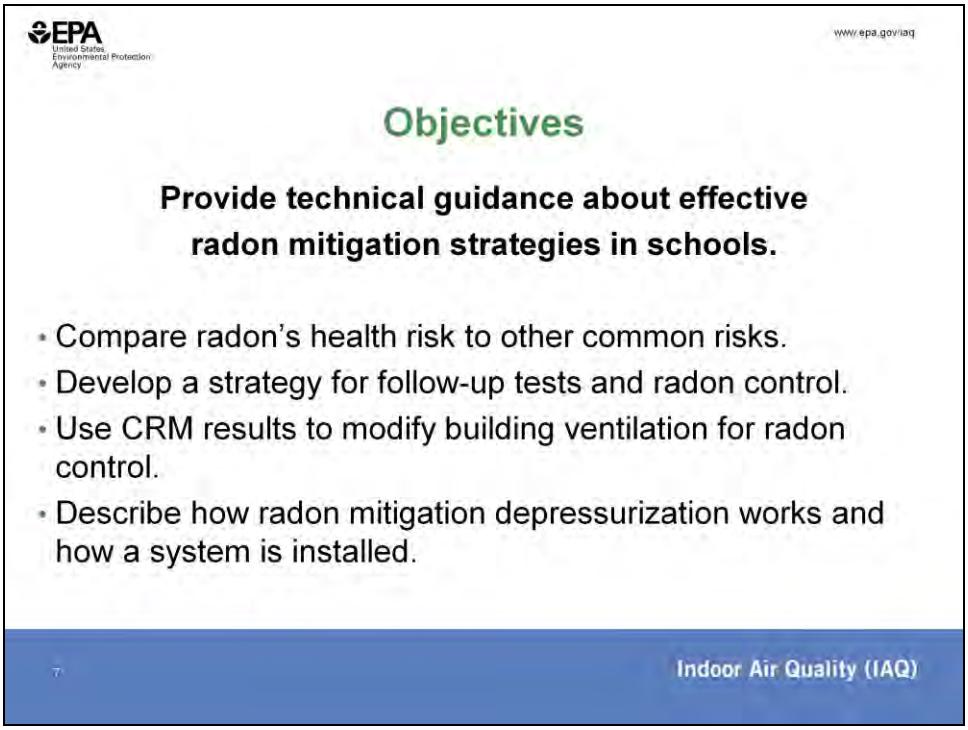
But we're not in this alone. Other federal agencies, in particular, the Department of Education is also very concerned about the indoor environments where people learn in this case. And to address that, they have instituted Green Ribbon Schools Award Program.



The reason I bring that up today is much of the audience is interested in this Green Ribbon Schools Award Program, and in fact, what we're doing today - this webinar, is part of their Green Strides Program to get people interested and up to speed on the issues associated with the Green Ribbon Schools award. Today, we're going to look at one of the three broad criteria that goes into this award program, and that's the healthy schools environmental aspect.



Now, within the healthy schools environmental aspect of the Green Ribbon Schools award is the one that's germane to us, and that's their Pillar 2A, the integrated school environmental health program. And within that environmental health program, there are various issues that could be considered as part of the award. The one we're most particularly concerned with today is under the broad category of contaminant control and that is radon and radon gas.



So, to accomplish our objectives today, we're going to provide you with some technical guidance; thanks to the courtesy and the expertise of our colleagues in Minnesota, Josh Kerber and Josh Miller. In doing that, we're going to take a quick look at radon as a health risk and then, turn it over to Josh and Josh to help the audience develop a strategy for radon testing and radon mitigation.

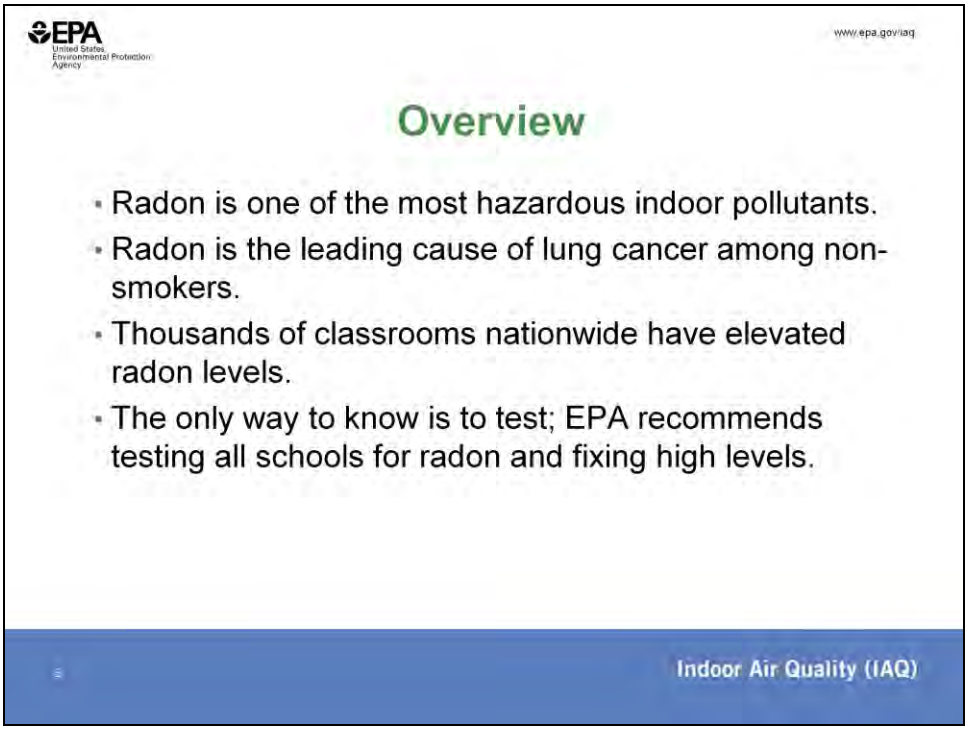
One of our pre-registration questions was how many people had experience with radon testing in their schools and had contacted their state radon programs. We're going to learn all about that today. We're going to get some hands on technical advice for using continuous radon monitors, that's what CRM stands for, and how useful that is in addressing radon within your schools.

And then by the time we're done in roughly an hour or an hour and 20 minutes, you'll have a good working knowledge of radon mitigation depressurization systems and how a system could be installed in your school either by a school maintenance facility staff or radon professionals that can do that.

So, that's the context that we're kind of operating within today to provide you with some basic but technical information on radon in schools, how

to test for and how to fix, and that fits within the larger arena of the Green Strides Program, which is to augment and promote the Green Ribbon Schools award.

So, that’s where we are and where we’re going next is I'm going to turn it over to my colleague Jani Palmer who is a scientist here at EPA, and she's going to provide you with some background on radon and why it's an important issue for our schools to consider. Jani?



Jani Palmer:

Hello, Lou and thanks for the warm welcome. And to all, thanks so much for attending. My job here is just to provide an overview. Indoor air quality pollutant levels are often two to five times higher indoors. And sometimes, they're up to a hundred times higher.

Radon is one of the most hazardous indoor pollutants. Radon is a cancer-causing radioactive gas found all over the U.S. in any type of building. It comes from the natural breakdown of uranium in soil, rock, and water and gets into the air you breathe. You can't smell it or taste it.

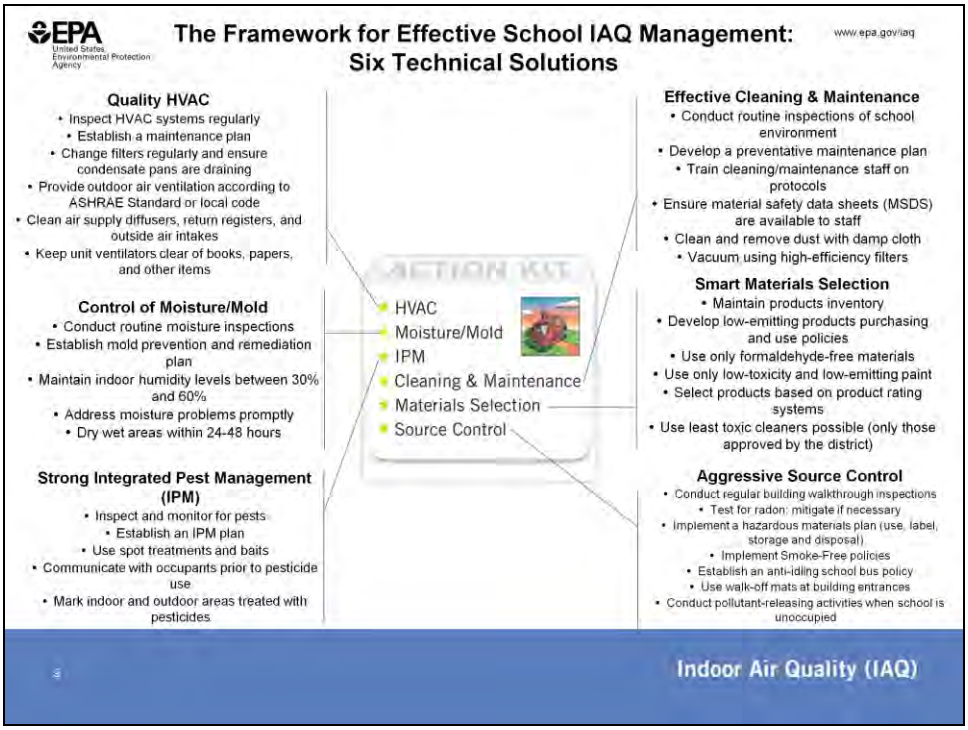
Twenty-one thousand deaths are caused each year by radon in the U.S. The surgeon general has warned that radon is the second leading cause of lung cancer in the U.S. today. Only smoking causes more lung cancer deaths. Thousands of schools are affected by radon.

In the National School Radon Survey, nearly 20 percent of schools had at least one classroom with high radon levels. Children and staff spend a substantial portion of their time in schools. High radon level in a classroom affects the 20 to 30 plus children and staff that will spend time in that classroom.

So how do you know if you have radon? The only way to know is to test. Several states have laws that require school testing and some

even requires schools built with radon-resistant construction features. Testing and fixing radon in your school can be affordable.

Costs can be quite variable depending on how many rooms have high levels, where those rooms are located, and other factors. Costs can be on the lower side if few classrooms are high or if the school is able to reduce radon by managing the HVAC system.



In addition to radon, EPA has worked to help schools incorporate management of a variety of IEQ issues. EPA's Indoor Air Quality Tools for Schools Program you see here provides clear and comprehensive guidance to schools on how to build and sustain an effective IEQ management program.

Radon control is found in the Tools for Schools Program under Aggressive Source Control shown on the bottom right hand side of the screen.

Successful school IEQ management programs are works in progress, and most districts put the components of success in place over time. The Framework for Effective School IEQ Management Key Drivers shown here is this system enhanced by continuous enforcement that helps with focused planning, implementing, and evaluating your particular actions or needs.

But how exactly does a school test and mitigate for radon? A practical first step is to refer to the IEQ Tools for Schools framework in our Managing Radon in Schools guidance. And you can find it online and we'll provide that resource at the end of the webinar as well.

Radon testing and fixing can be straightforward processes, steps include procuring and placing radon test devices then collecting them,

and sending to a lab for analysis. Based on results, schools will decide what to do next. And to help you along the way, here are two who have successfully used the Key Drivers for radon in hundreds of buildings. Josh Miller and Josh Kerber, scientists at the Minnesota Department of Health, please take it away.

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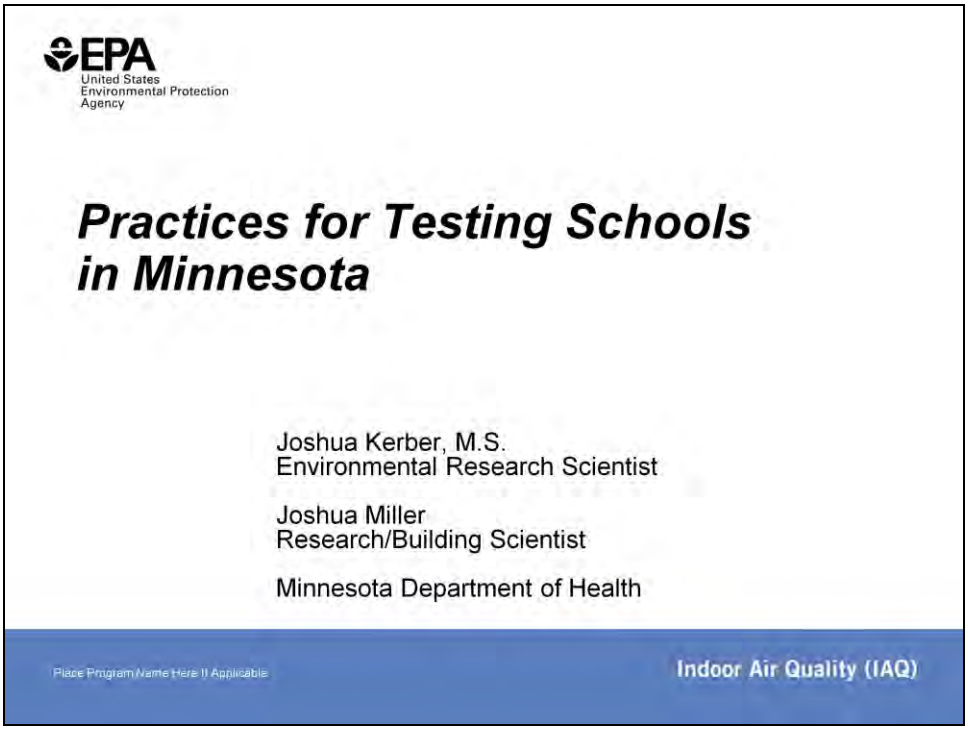
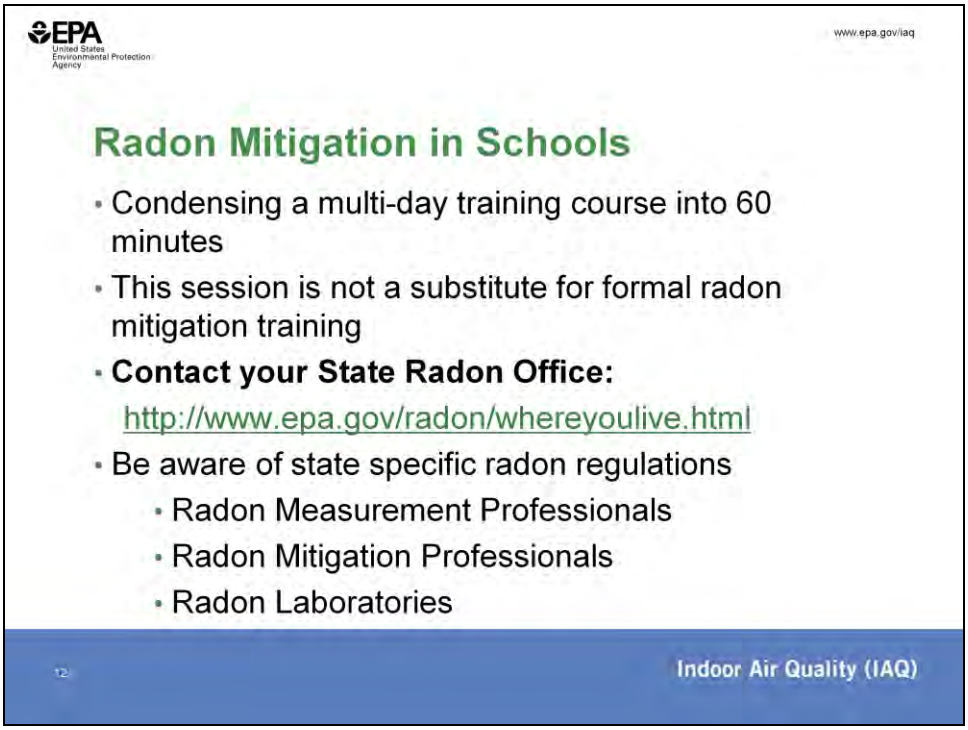


OK. Thanks, EPA and thanks Lou and Jani for the opportunity to share experiences from the great state of Minnesota. We'll move on to the next slide and try to be as brief as we can for brevity sake and perhaps have some question and answer at the end.



This webinar is condensing many, many days' worth of radon training into roughly a 60-minute timeframe. We're not going to cover everything. We can't. We're not going to cover walkthroughs in schools. We're not going to go through the nuances of testing and mitigation, at least like the tricks of the trade so to speak. We're also not going to cover how schools can come up with their own radon specific radon plan other than to say every school should have a radon plan. And that also includes the communication part of that plan. Arguably the most important plan is the communication section.

It's not a substitute for a formal radon mitigation training either. It all starts with folks contacting the state radon office and if you don't know who that contact is, EPA has a webpage where you can find out where that is and that's posted on your screen right now.

Another word of warning, cautionary tale in many states is that some states do regulate the practice – the professional practice of radon testing, radon mitigation, and also radon laboratories. Next slide.

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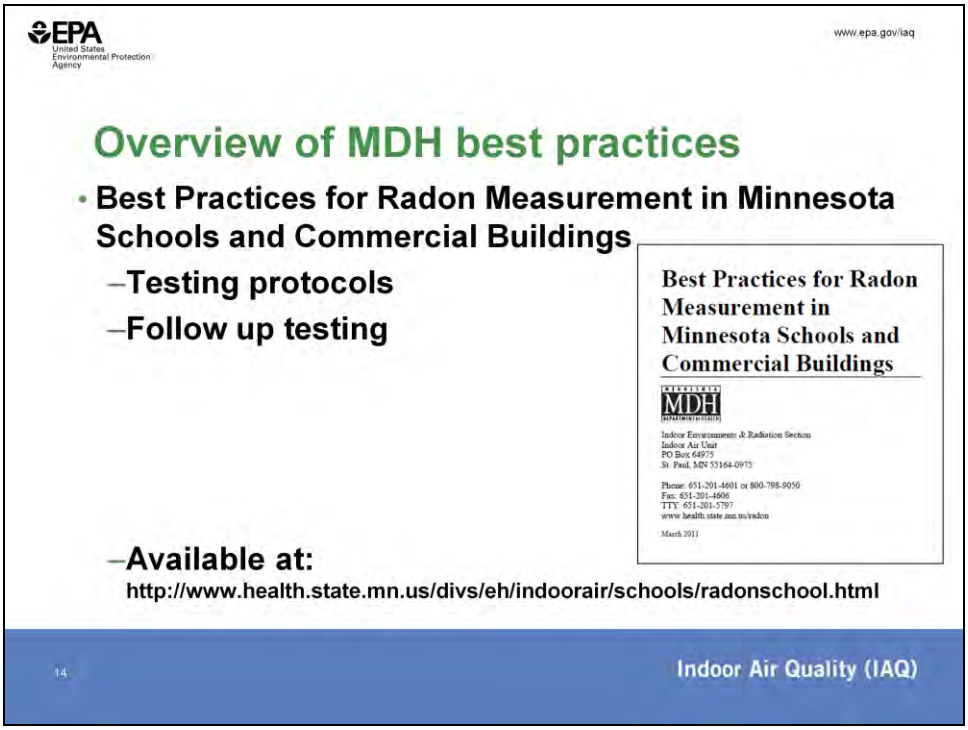
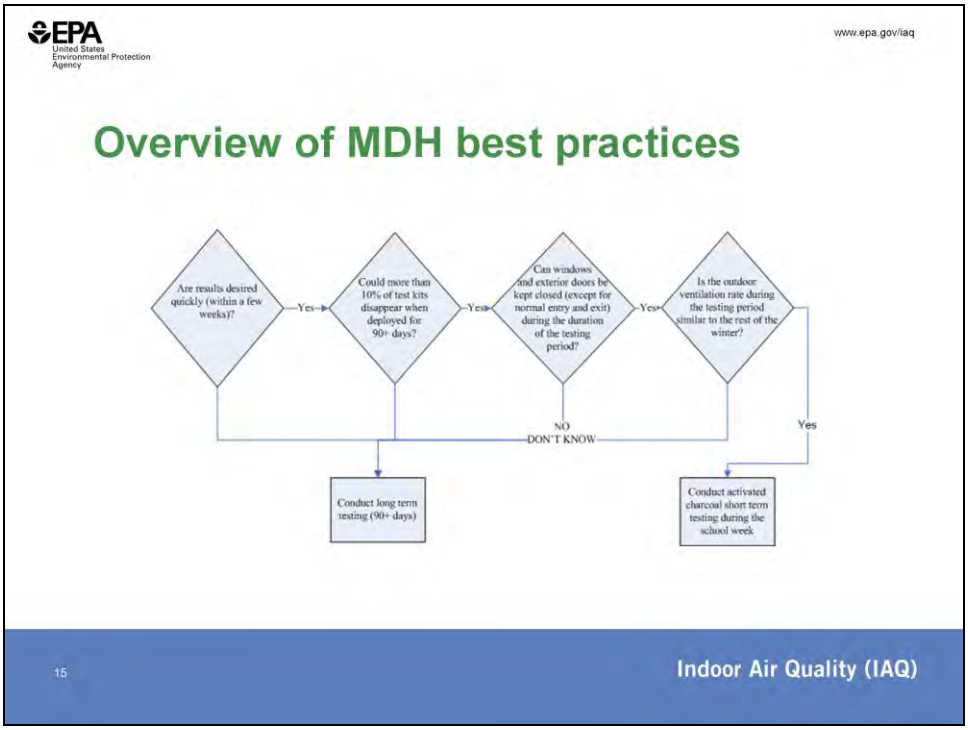
OK, this section, we're going to go through our overview of the Minnesota Department of Health best practices for radon measurement in schools and commercial buildings. This is based on many techniques from the Tools for Schools campaign as well as introducing some of the tricks of the trade and lessons learned from our field experience. Next slide.



So, here's a cover picture, a picture of the cover page, and this document is available for free download at our website, and that's on the bottom. It goes through our testing protocols as well as the follow-up testing which Mr. Miller will discuss.

The testing protocols in short are – we're going to test for say, two to seven days, actually about two to five days, every regularly occupied room with ground contact in every school building. We're testing to find areas where high radon may be present and confirm them with follow-up tests.

Years ago, EPA has drawn a line in the sand and our magic number, if you will, of 4.0 picocuries per liter for radon. We're still using that logic today, but it's also key to note that the level of four is not a health-based standard. It's simply a line in the sand where we say at or above four, we're going to fix it. That level is also the same level we use in residential exposures. Next slide.

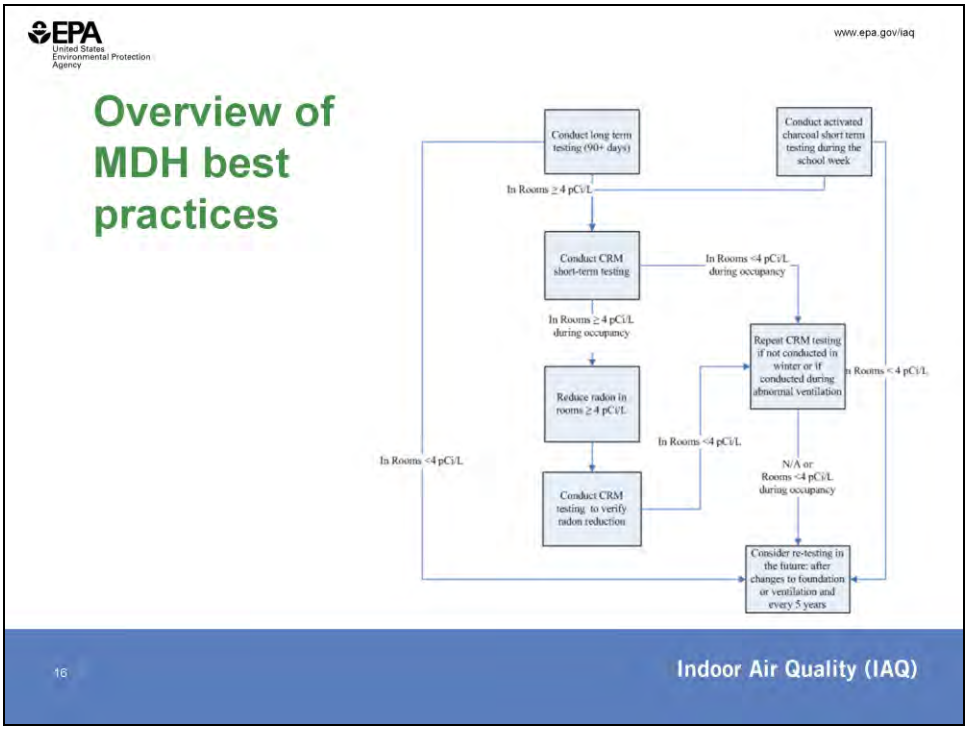


When you look at our best practices, you'll see a series of flow charts. This particular flow chart discusses what kind of radon testing we should start with. The chart on the left hand side, the question is, are your results desired quickly – usually within a few weeks. If the answer to that is yes, we continue to the right hand side of the chart and if it's no, we simply say, you can conduct a long-term radon test.

Personally, I'm a proponent of a short-term radon test which is the two to five-day test done in the heating season, and in Minnesota, we often can go from say, September to April as the heating season, or as little as December to February as our heating seasons. So, we try to do tests during that time period.

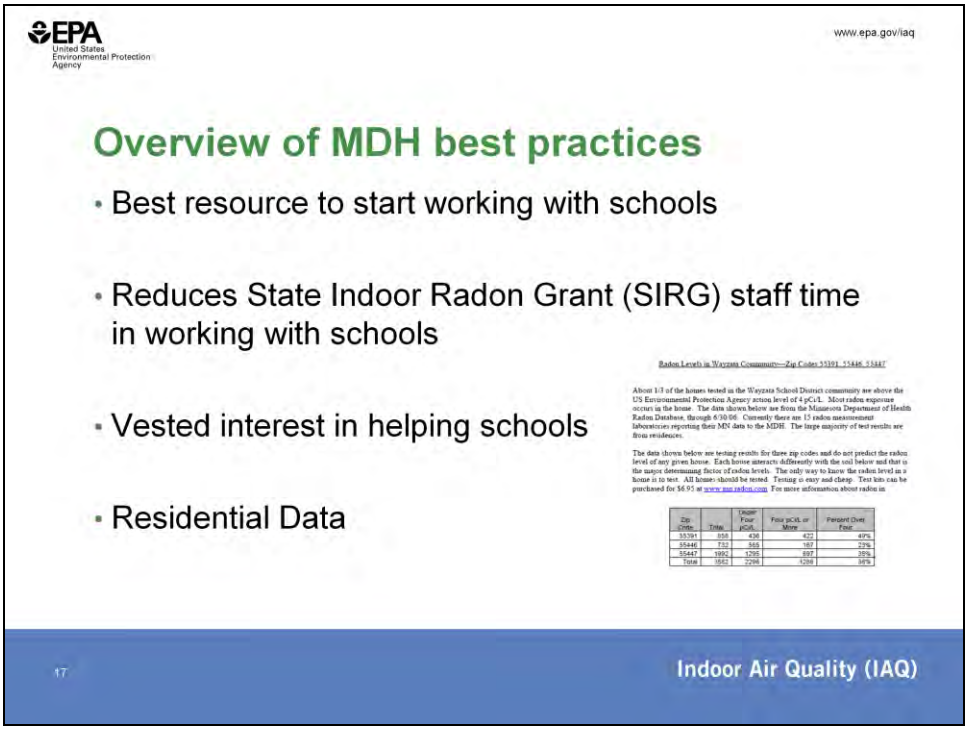
But in short, we want our results fairly quickly. We want few of our test results or, I'm sorry, our test devices to walk away whether they fall down, get knocked around, get stolen, thrown away, what have you. In the wintertime, we keep our doors and windows closed, which is the closed building conditions discussed on that third diamond. And finally, the outdoor ventilation rate during the testing period similar to the rest of the winter, and typically, that's going to be yes as well for us.

So, most of our schools are answering yes to those questions which points them to conducting activated charcoal short-term testing during the school week when the school is on occupied mode. Next slide.



This particular flow chart is kind of the bottom part of the one we just discussed where we're going to conduct our short-term radon test and based upon the results, we make a decision. If it's less than or greater than four, we consider retesting in the future after we make any changes to the foundation or ventilation of the school and every five years.

If the answer to the radon question– are they're elevated – is yes, then we conduct a different series of radon follow-up radon tests. Mr. Miller will actually go into that in a little bit more detail specifically continuous radon monitor results. Next slide please.



These best practices really outline the process for schools and consultants to use in our state and likely in many other states. It uses less state indoor radon grant or radon grant funds or staff time and we have many staff that are partially funded and because we have this guidance out there, we're taking fewer upfront questions, which is a benefit to our program because then we can focus on other areas for radon outreach.

The schools have a vested interest in using this and we have a vested interest in helping schools because they are our number one partner trying to get to children. And we do also discuss in the best practices communication portion the residential radon data. This is a very key point to bring home. It's a way of controlling fear of the staff and parents when they're making a letter saying we're doing radon testing. They may not know what it is. They may be scared or have concerns, and a lot of that can be quelled to an extent with a communication plan upfront.

And also, when it comes to radon exposure, while children are at school a significant amount of the time, when you weigh it, as far as time per week or time per school year, children are only in the actual school building maybe 10 to 20 percent of the time. Whereas they're at home, depending on how you cut it, 60 to 90 percent of the time. So, really the

risk to radon exposure is at home. And we would also urge any staff as well parents to test their own homes for radon.

And with that, we'll go to the next slide and I'm going to turn this over to Joshua Miller to talk about continuous radon monitoring (CRM) following an initial round of radon tests where we have elevated results.

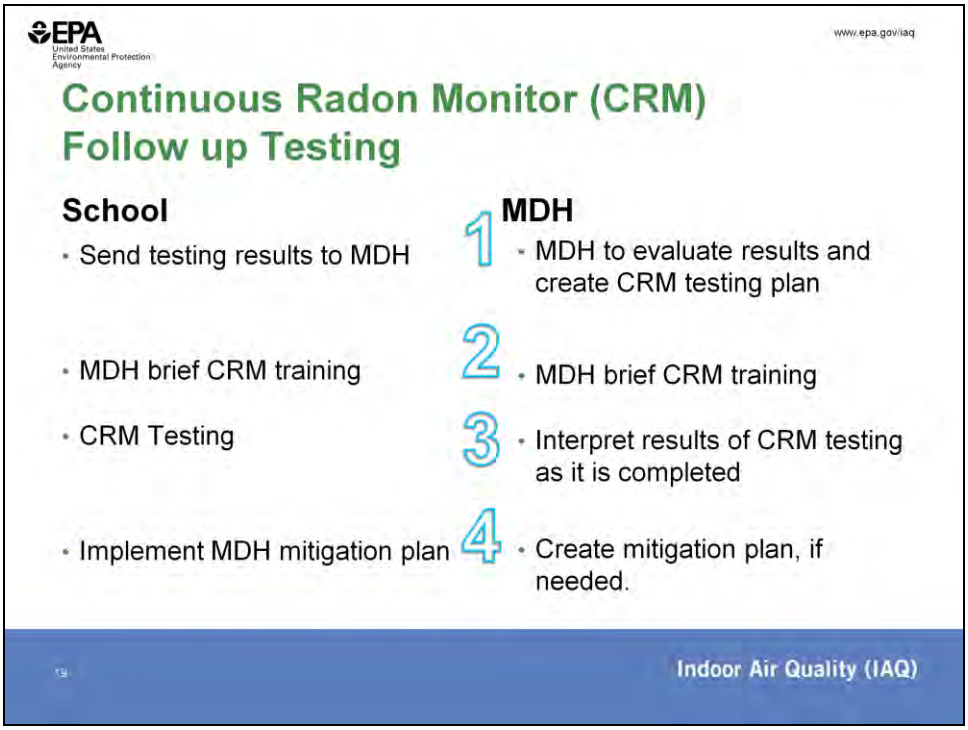
All right, I'll take you through what we do for CRM testing. We've very strong components of CRM testing as you can see from our flow charts for two major reasons.

First, it's cheap to implement and it's something that's easy enough for the school staff to do if they have a technical expert working with them. And in the long run, it can save a lot of money. You know to do a minor fix, it could be zero to a few thousand dollars to reduce radon levels in the rooms that came back high. Or if, they move in to an SSD system that can be costing, you know, $20,000 to $50,000 to fix the school. So, we want to make sure that we fully define the problem and understand it upfront.

As far as cheap to implement, we use one particular brand of CRMs that's made by Femto-Tech, Inc. They do do a monthly rental program and it's a $150 a month to rent a monitor. So, even if the school doesn't have access to a radon program, they still could rent the monitors themselves.

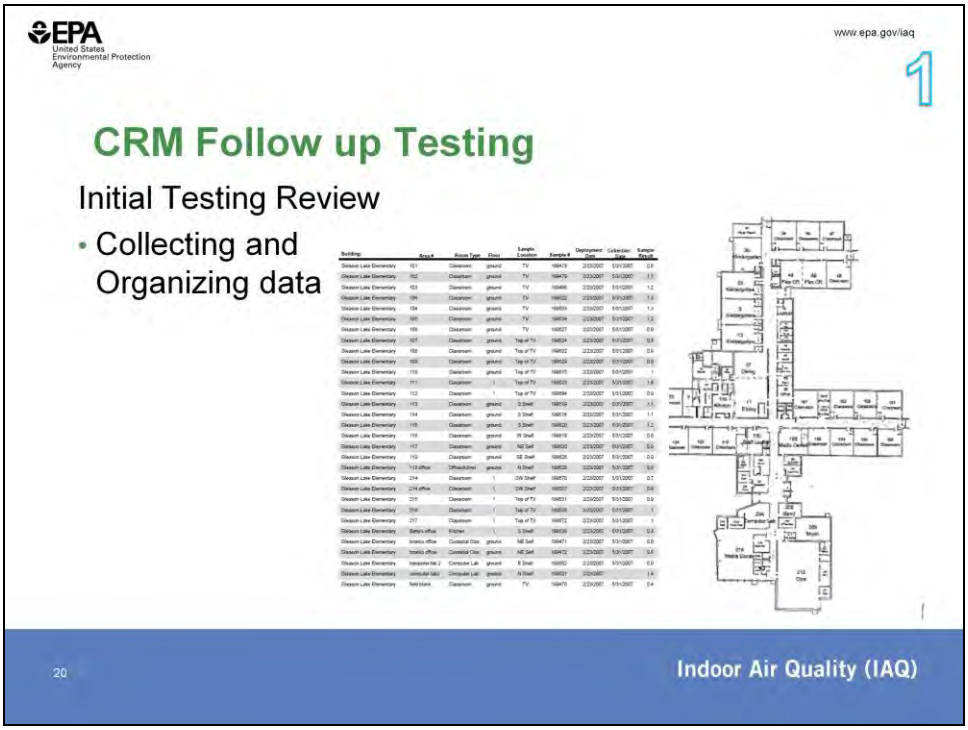
I did look at the initial polling questions. We didn't really have anybody that has used CRMs and so I probably should briefly explain what a CRM is. Essentially, it's an electronic device that takes radon measurements on an hourly basis so that we can see the variations and fluctuations so we can better understand the radon flow inside the

school. Next slide.



To break it down into what I'm going to talk about essentially, four main steps. The first step is to gather everything that we need to evaluate in the original testing plan that was done. This is important because we want to make sure that the tests were done rights, that they are valid tests, and we have a good idea moving forward of what the problem might be.

We do a brief CRM training. I'll take you through that. It only takes about a minute to understand how to use our devices. And then once the testing gets rolling, essentially, they send us the results and we start interpreting them, and then we can create a mitigation plan if needed from there. Next slide.

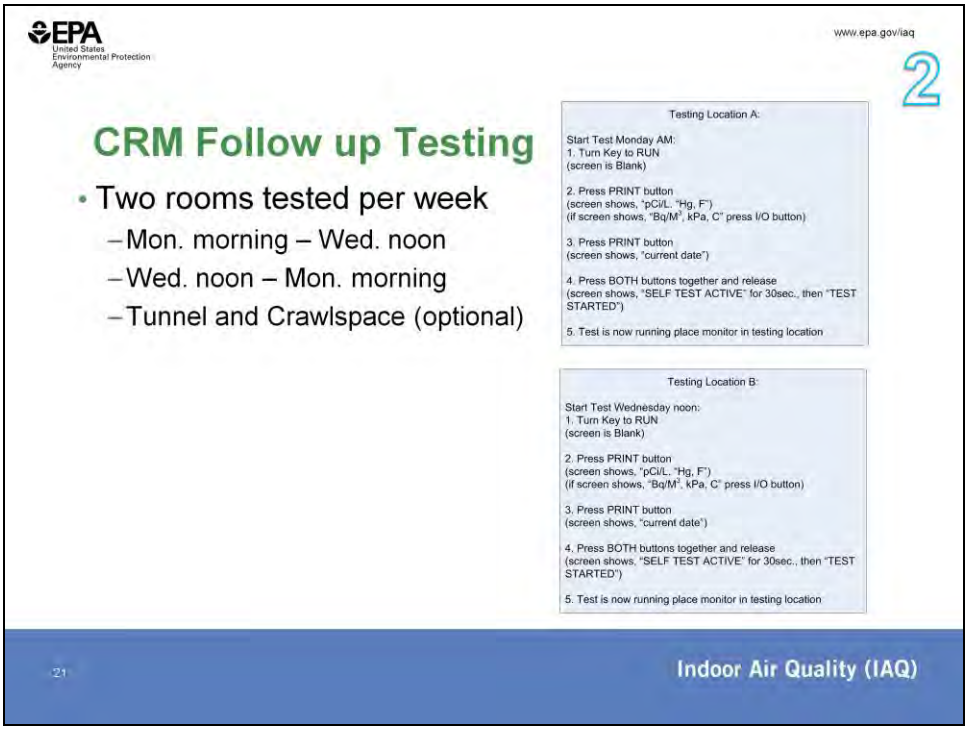


So, on all of my slides, there'll be a little blue number up on the right corner that just corresponds back with the four steps that outlined originally, and this step really is the most important part especially for me in the radon program since I haven't been out to the schools. I didn't do the original testing. I'm trying to play catch up, and it's really helpful if I have building floor plans so that I can, you know, start writing on the floor plans to lay out all the testing. I might be able to start finding some trends or some problem areas in the building, so that I can kind of coach people from the sidelines.

The basic questions that I'm asking myself or the school to get all the data is: were all the room tested? If they weren't, why weren't they? Maybe we do need to do some more initial testing before we move on to follow-up. What kind of test was conducted? Was it a short-term test or was it a long-term test? There are very big differences in the amount of time that they look at, and if the building has really high levels on the evenings or on weekends that can really distort the ending radon level on long-term kits.

I look at how many rooms actually need follow-up testing. Mainly, that's to find out is the CRM a good option? Do we need to do short-term tests or do we have to come up with some better testing protocol to make sure that we get all of our testing done within the window that we have?

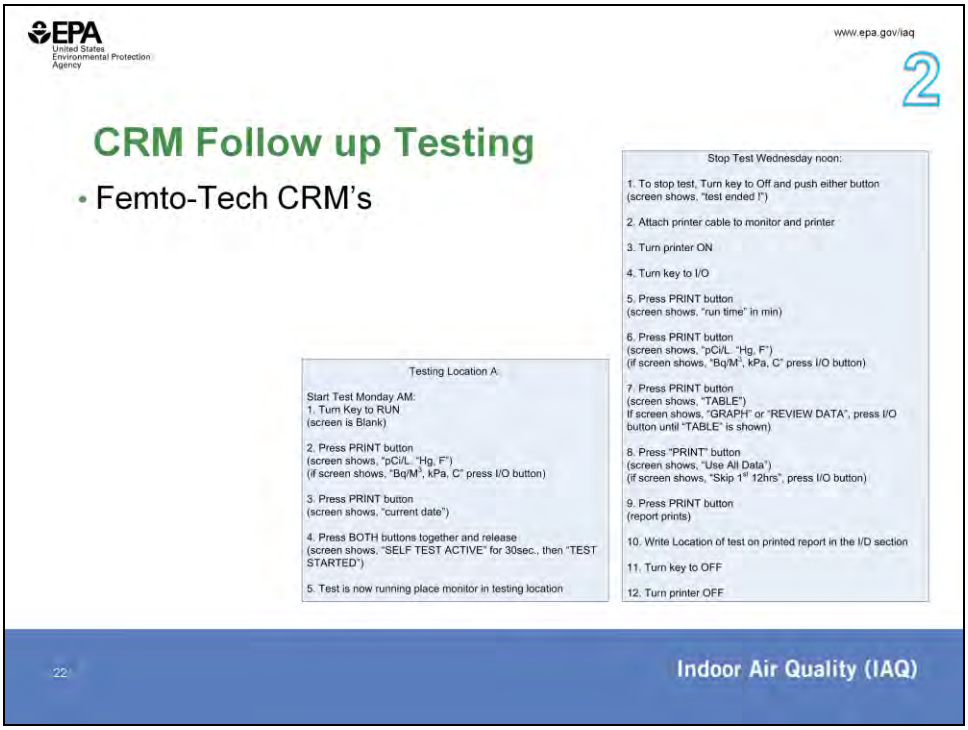
So, next slide.



So, this is our proposed plan. Generally, as we do two rooms per week, then we set up a schedule based on that and we go from Monday morning to Wednesday afternoon. And on Wednesday afternoon, the monitor gets moved and it's just there until the next Monday morning.

We need a minimum of 48 hours of radon testing data to be a valid test in any given location. So, this allows us to have that 48 hours and it also gives us the chance to see weekend events and how the building's actually operating over the weekend, which can be very valuable when we get to the next stage of actually creating the mitigation plan.

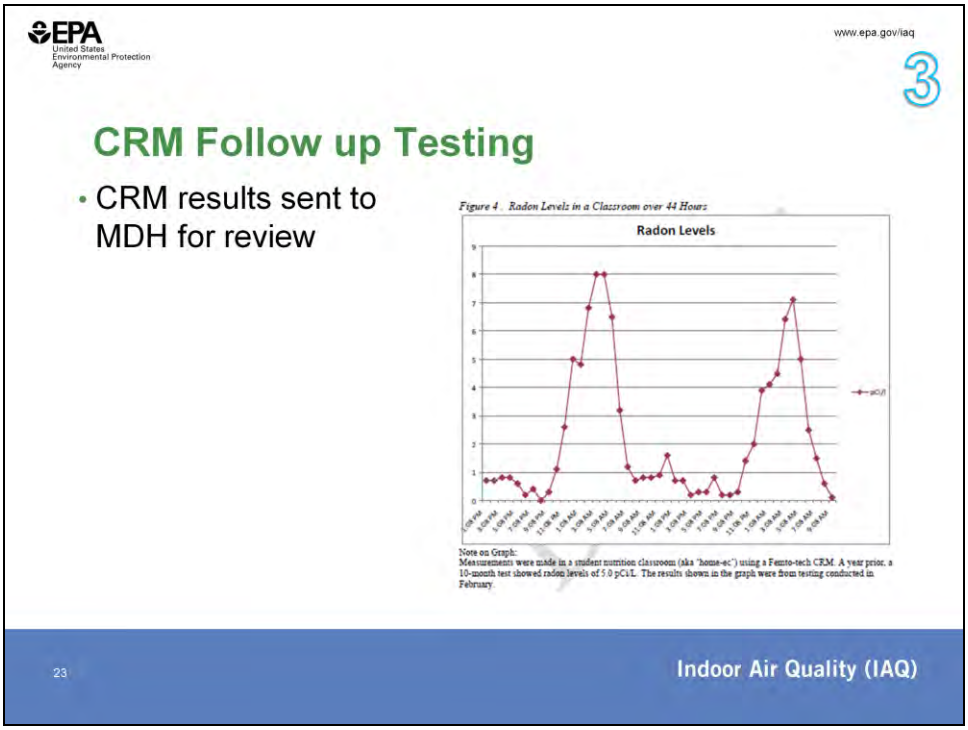
And then the tunnel and crawls spaces, really that's kind of usually a follow-up test just so we can start tracking down where the radon might be coming from. Next slide.



So, this is essentially what we handoff to the school with our CRMs. We use the Femto-Tech, Inc. brand. There are a lot of other brands out there. So, I'm just kind of going through Femto-Tech, Inc. because that's what we have. So, essentially you know it's only five steps to get the test running and to leave it there.

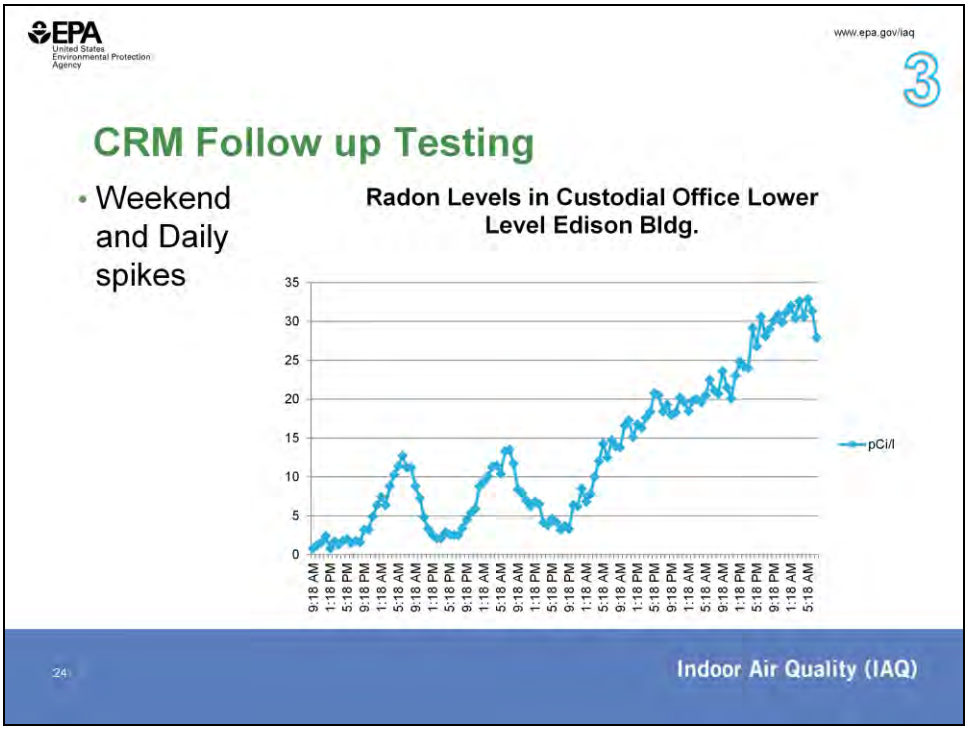
The test also does have tamper devices built in it. So, if it gets moved, it will actually register on the printout that the monitor was moved. So, we can correlate if the teacher moved it, did it just get bumped, and the corresponding radon change from that – maybe from the bump, may not be from the bump, but it's valuable to know.

And then it's just a short twelve step process to print in out. Once it's printed out, generally the school will either collect them all at the end, email or fax them to us, or if they're really interested, they may do it every time that they test. Next slide.

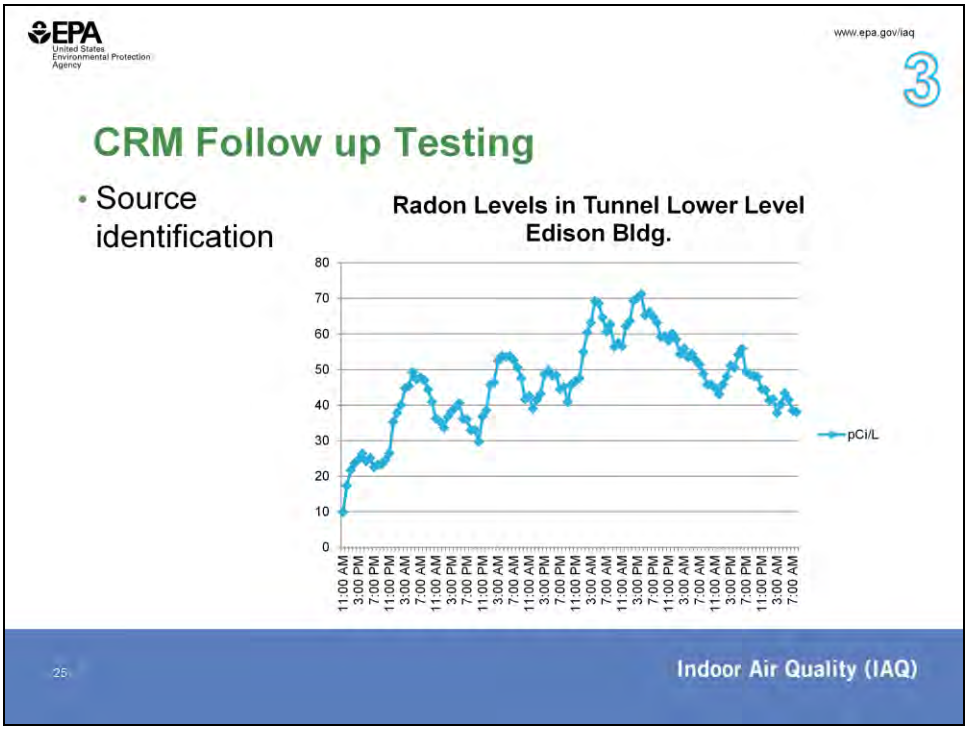


And once you get that data back – this is what we're looking at. These are hourly radon data points. In this particular slide, you can see the air handlers being turned on during the day. Then, they're turned off in the evening and the radon spikes. And then they're eventually turned back on again the next morning.

So, generally, what we're looking for here is just that the occupied hours. What is the radon concentration? Because if the radon level is high at night but it's low during all occupied hours, it's not necessarily giving a large exposure risk. But then, we do have to deal with things like, are there going to be after school events? What do the air handlers do then? Are there weekend events? Is this weekend an issue? So, next slide.

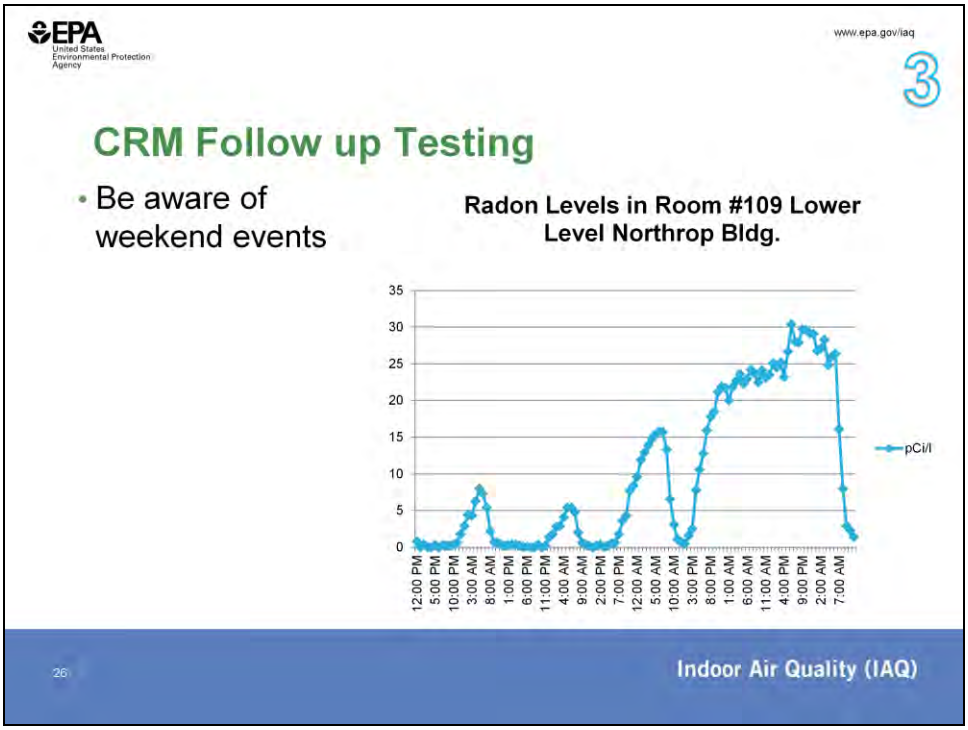


So, here's an example of two daily spikes and then a big ramp up for the weekend. This weekend ramp ups can be really problematic. As you could see, it has a fairly steady decline on a daily basis. But when you add that same decline onto a full weekend ramp up, it could take actually almost all of Monday for the radon levels to come back down. So, that could be a potential concern. Next slide.

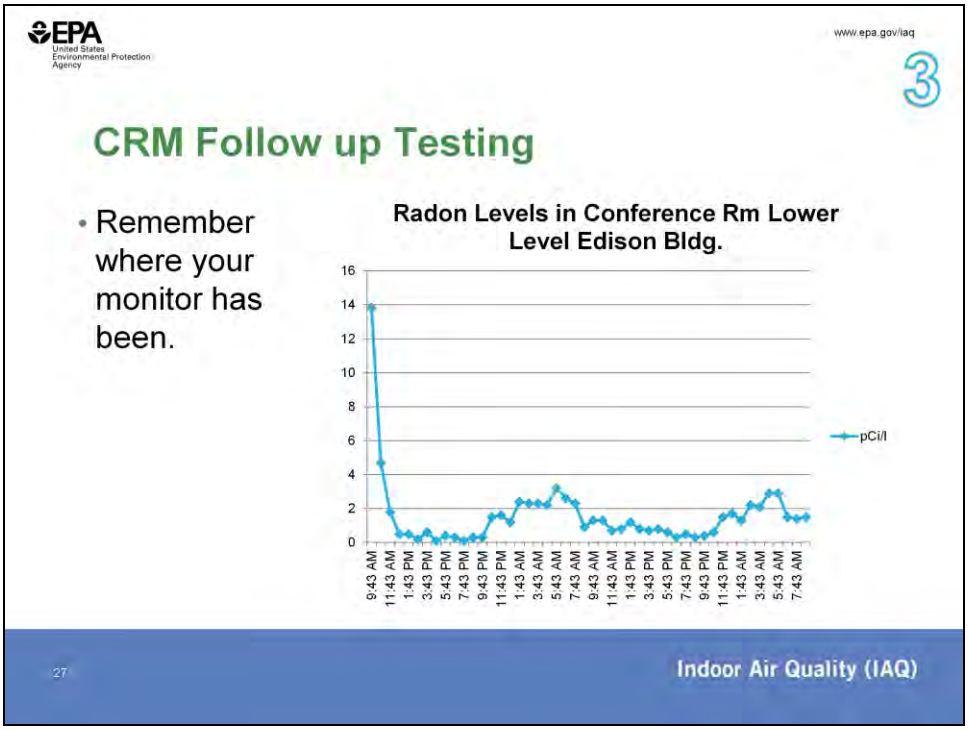


And the scale changed on this one, so you could see that we just kind of, we tossed it in the tunnel to understand what is the tunnel's relationship to the rest of the radon levels in the classrooms that were over the top of it?

You can kind of see some connection between the air handlers dipping and then this was also run over a weekend. But just a note here that the concentrations in the tunnel were 70, where there were only nine in the classroom. So, next slide.

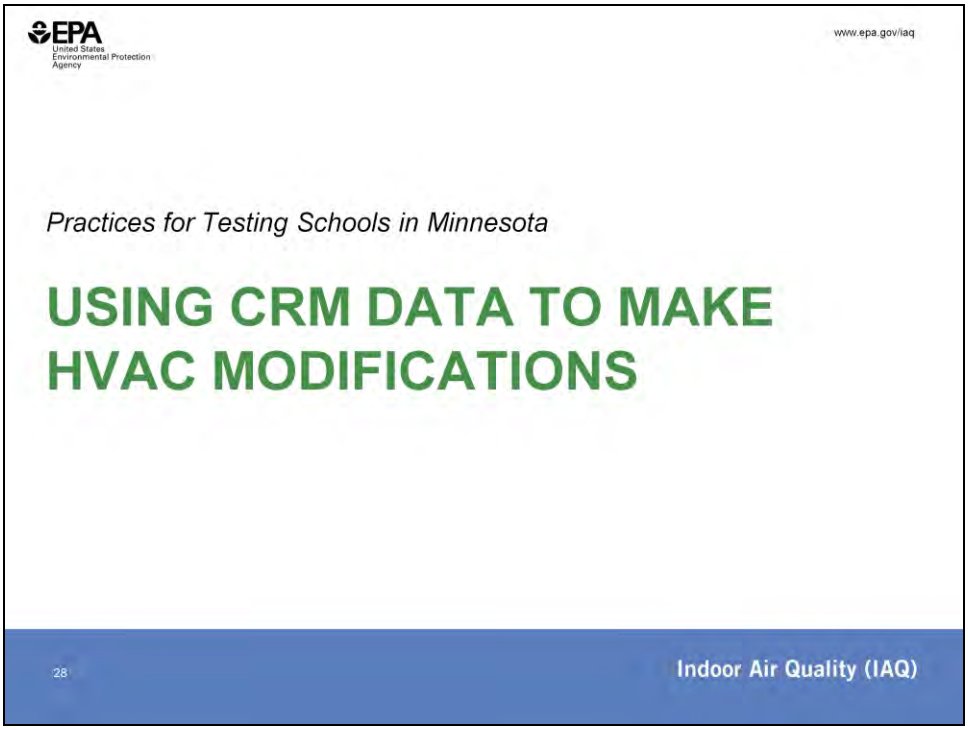


And beware of weekend events that can be throwing off some of your data. You can see two daily spikes going into a weekend ramp up and there is a Saturday basketball game. Good to know that they ran the air handlers for the event. The radon did come down for the basketball game but then it went back up. Next slide.



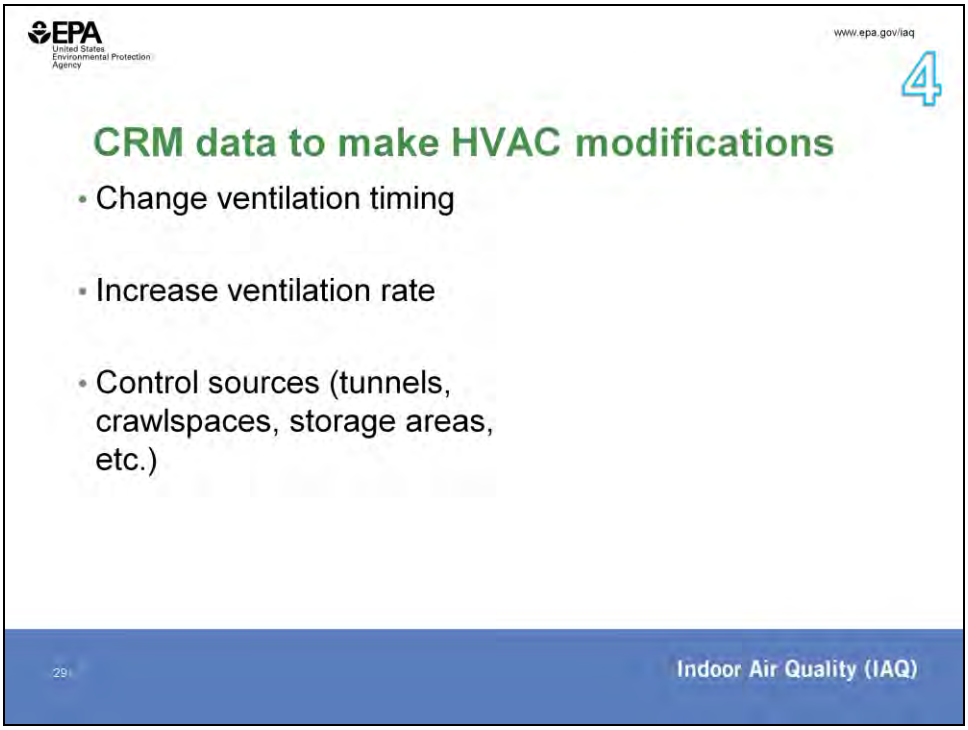
And we also have to remember where the monitor's been. So, it's easy enough to figure out for me because it gives me the days and time when our monitor was running and then there's a place where the school fills in the location. But this actually came out of one of the crawl spaces we are working on and then it got moved into another classroom.

It essentially can take, you know, up to four hours for the radon monitor to equilibrate with the rest of the radon in the room. So, that can actually really distort your test. And those are the things that we're looking to throw out and redo the average for the radon results. Next slide.



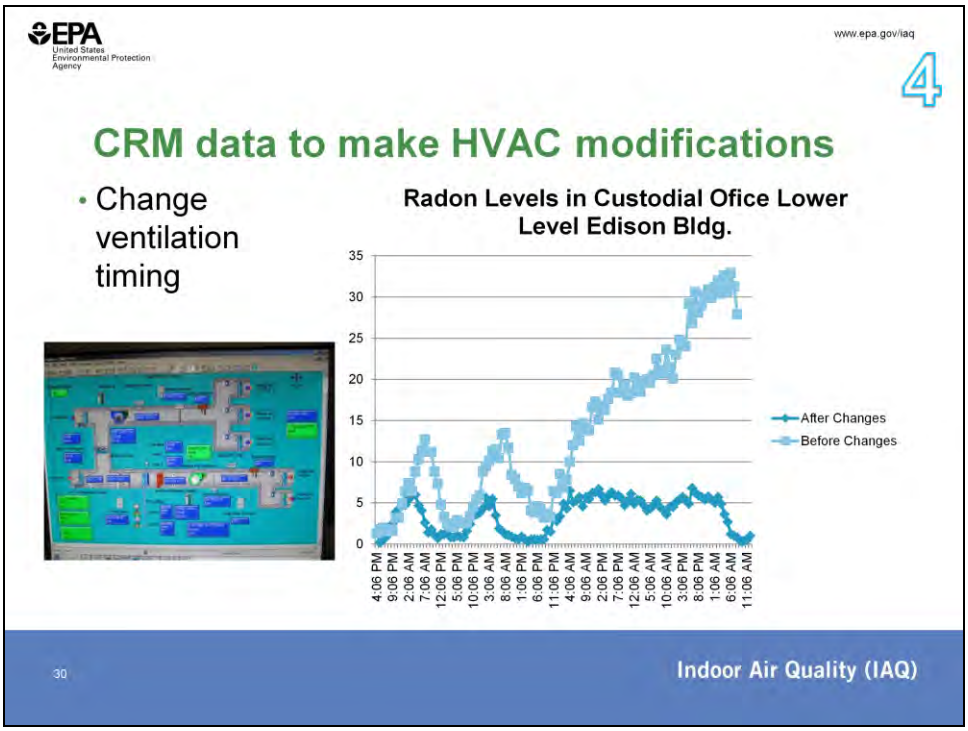
All right, that's pretty much what we do with the CRM. Now, we're going to kind of go through quickly how I tweak the HVAC systems and then we'll do another set of CRM tests after that. But once the problem's fully defined, it's pretty easy to figure out how to tweak the ventilation. The ventilation's only going to work in schools that have univents or forced air furnaces, or rooftop HVAC units.

So, there's going to be a good chunk of schools that have boiler rooms and tunnels and things like that. We have to move to source control and make our own mechanical ventilation. Next slide.



So, I'd briefly touched on these. These are the three things that we want to look at. Do we need to change the ventilation timing to make sure that the radon levels come down in time, like the weekend event? Do we need to increase the ventilation rate to the room to actually pressurize the room to push the radon out? Or do we actually have to bring in more outside air? And if we have a strong source, can we just control the source and then ignore the ventilation completely?

It kind of goes from minor changes at the top to major changes at the bottom, and obviously, they're going to be – even though there are cheaper changes to do HVAC, the long-term operating costs can be a lot higher. So, that’s something else the school has to weigh in their decision on how they want to mitigate radon. Next slide.



So, a lot of our schools fortunately that have rooftop air handlers have these fancy programs that run and control all of the timing and everything else. So, these schools are great to work on for us, and they make great examples because we could just go login to the system, tweak the timing of it, and essentially lower the radon level.

So, what we ended up doing in this case is for a short period, around midnight, the air handler would kick on for an hour which kept the daily spikes down, and then it would cycle on and off for a two to four hour period throughout the whole weekend so that there was no major ramp up. So, that Monday morning, when it kicked on full blast again, the radon levels came way down. Next slide.

EPA United States Environmental Protection Agency

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4

CRM data to make HVAC modifications

- Increase Ventilation Rate

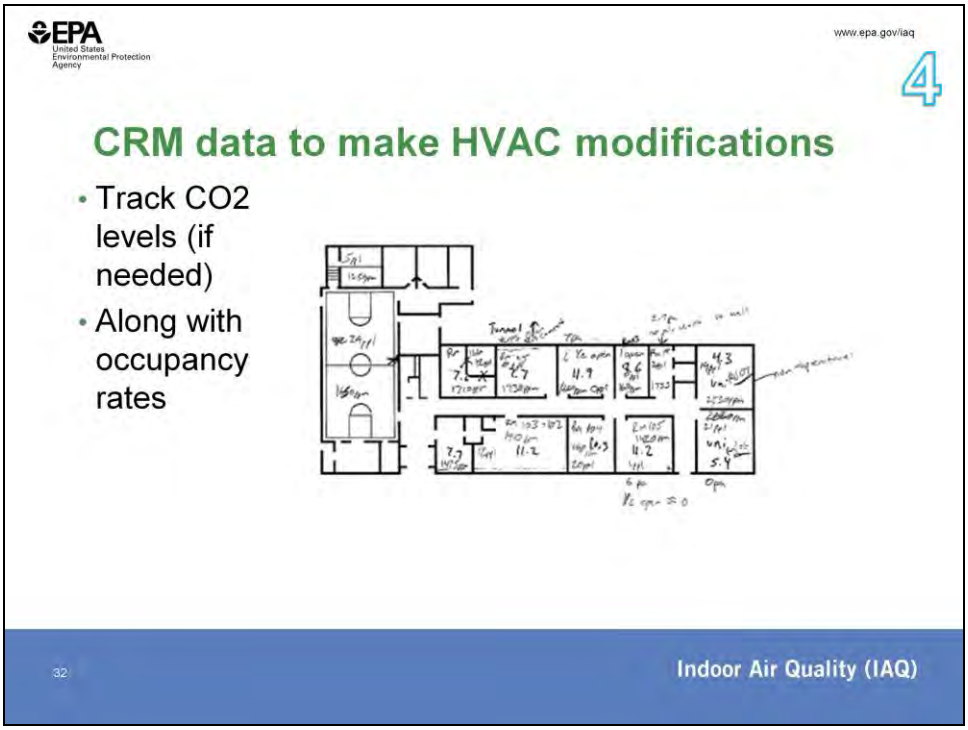
Room	Initial	CRM	After (20% outdoor air)	
100	8.6	7.6	3.4	
102	10.2	7.7	3.5	
104	11.9	11.9	3.2	
106	7.4	8.6	2.8	
108	5.1	4.3	3.9	univent
110	4.8	5.4	2.4	
112	13.1	11.2	3.1	
114	12.2	10.3	2.9	
116	109	11.2	3.8	
118	8.3	7.7	3.7	

31

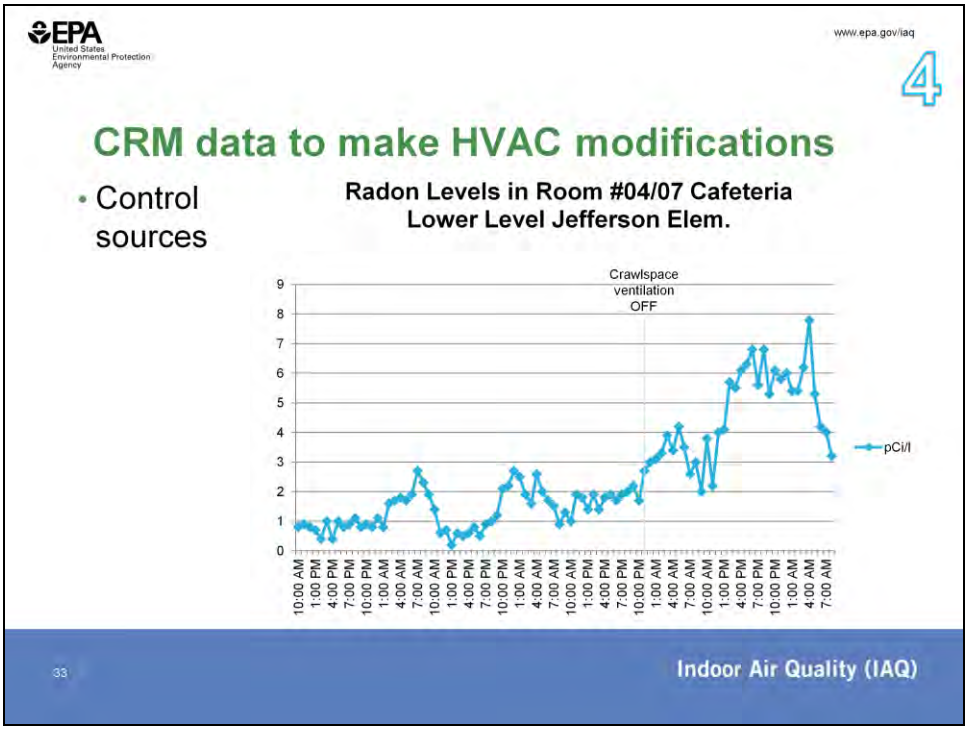
Indoor Air Quality (IAQ)

And a lot of our time, this is essentially what we're doing during our walkthroughs. We're looking for broken equipment. Are the outside air dampers open- that left picture? Or the inside air dampers open, that's the right picture? A lot of times, we find that one's either stuck or broken and it causes some general indoor air quality issues.

As you can see, this whole building actually was high. It was high with the initial. It was also high with the CRM. Then we actually just fixed the damper that was broken to run it back to the 20 percent after air that it was supposed to be at. And it actually fixed the school, which was great because this school actually used dirt tunnels as their supply ducts for all of the rooms. So, we actually thought it was going to be quite difficult to fix the radon problem, but it's amazing how much just a little bit of outdoor air actually does. Next slide.

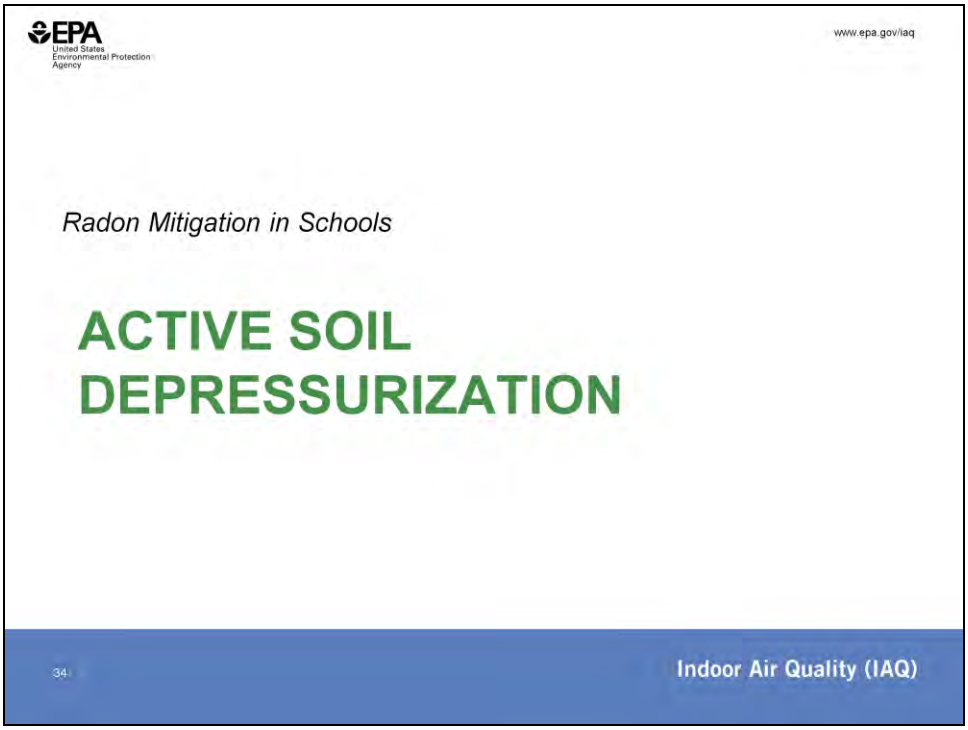


But we had to justify to the school that, you know, ramping their ventilation back up to where it used to be was actually in their best interest. With shrinking school budgets, they didn't want to increase their heating and cooling costs. So, actually we went through with a CO2 monitor and logged all of the radon data along with CO2 levels and the occupancy rates of the rooms. And we basically showed them that they have a very widespread indoor air quality issue. So, the school actually was willing to increase their ventilation rates. So, next slide.

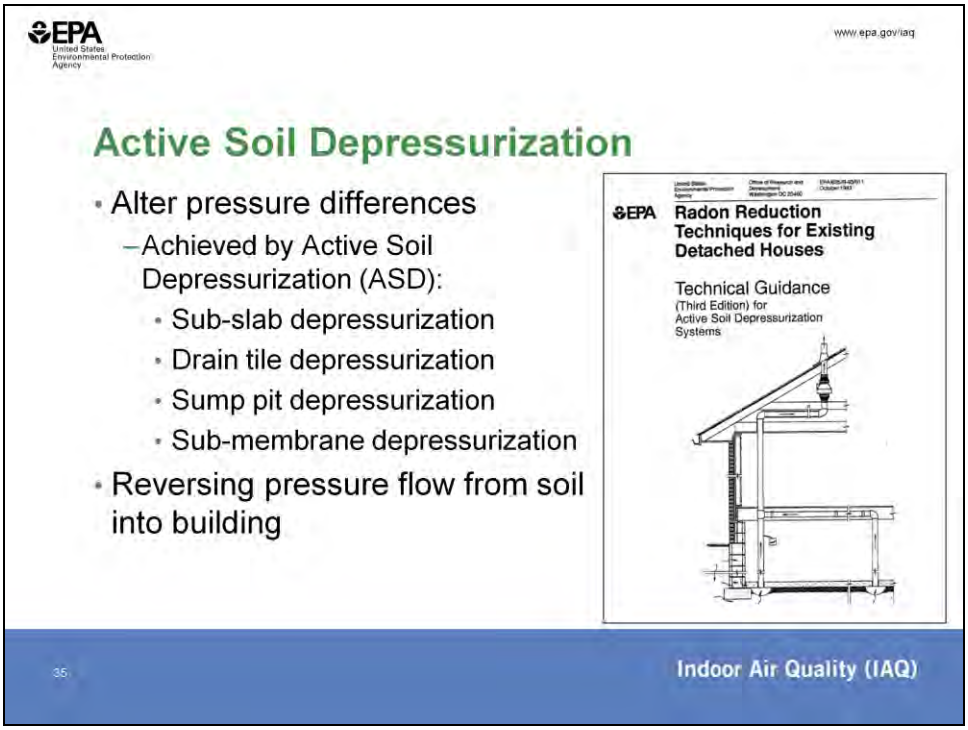


Here's a brief example of controlling sources. There's one of our schools that the whole cafeteria area was on top of a crawl space. The crawl space actually came back in the 50 or 60 range pretty consistently. So, we actually just took a $150 fan, put it in the crawl space and just put it on a timer so that it would kick on and off. And as you can see, it actually kept the radon levels low during the week. But then when we did turn it off for the weekend, it started to ramp up again. So, it is a viable way to create your own mechanical ventilation.

So, those are the kind of the quick and easy ways to take systems that are already there, tweak them a little, maybe boost them up a little to reduce radon levels. But if those don't work, then we're going to have to move into active soil depressurization. Next slide.



All right. This is Josh Kerber again. I'll be handling a lot of the active soil depressurization section. Next slide.



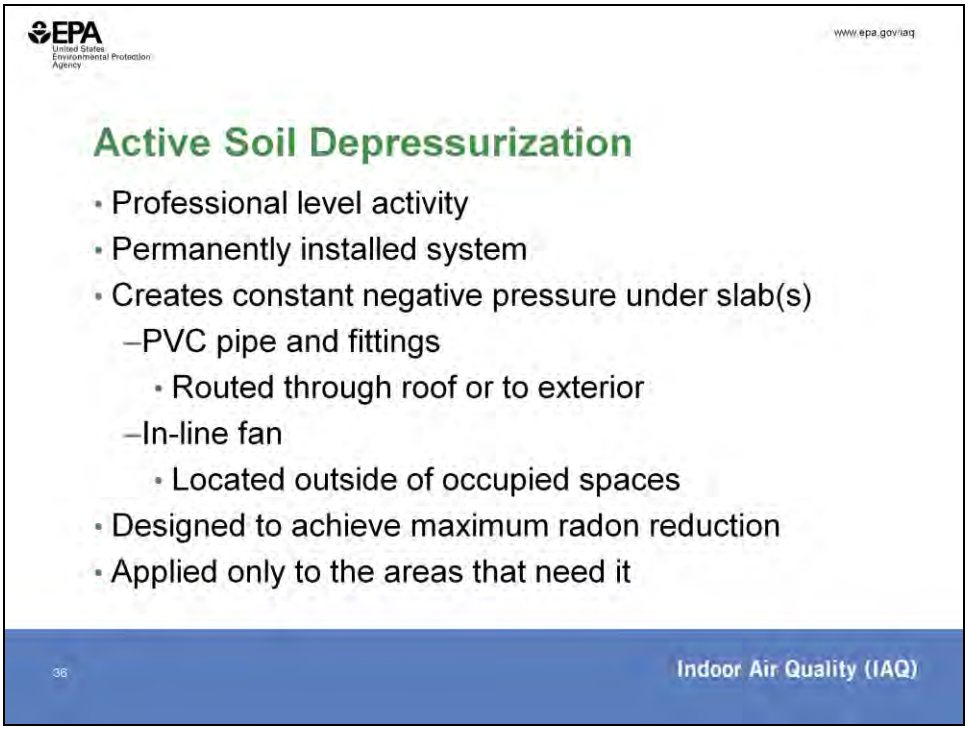
When we use the term radon mitigation, it really means reducing radon in structures but, by and large, when we talk about mitigation in homes, it's what's called active soil depressurization. On the right hand side, you see a screenshot of EPA's technical guidance for radon mitigation in homes.

So, we wanted to make you aware that there is some guidance out there for homes. In fact, there are standards in many states, standards for certification bodies, participants to follow.

The key driver is you need to know that your building may suck or your building may blow. Schools and commercial buildings often time blow, which is our way of saying that they're possibly pressurized in relation to the soil. But some schools suck, and in Minnesota many homes suck, which means they're running negative to the soil which means their pulling soil gasses in, which is how the radon is entering the building.

This is residential guidance that you see on the right, but the principles really are the same. And there are future standards for schools that are in the works. There as you see is a bolded list of different types of depressurization systems. These are all types of active soil depressurization. Some slab depressurization in our area is the most common. As we get further south, where we may find more crawl spaces under homes or buildings, sub-membrane depressurization may

start to become more common. But the idea here is that we need to reverse the pressure flow from the soil into the building. Next slide.



Active soil depressurization is really a professional level activity. A lot more goes into it than just what's in the presentation. It's a permanently installed system which means it needs to be operated and maintained like any other permanent part of the building. These are building-specific designed radon mitigation systems, and they need to be designed to take care of the problem and not much bigger. They're only as large as you need them to be.

The idea is that we're going to create a constant negative pressure under the slab or slabs with PVC vent pipes running through the roof, typically, otherwise through the exterior of the house where there's an inline fan attached and that fan is located outside the occupied spaces. Typically for schools, in our experience, it's been on the roof.

That's a design that means to achieve maximum radon reduction continuously, this isn't something that you turn on and off typically. This is something that you leave on, and is applied only to the areas of the school that need it. There's no sense in trying to fix a problem that doesn't exist. Next slide.

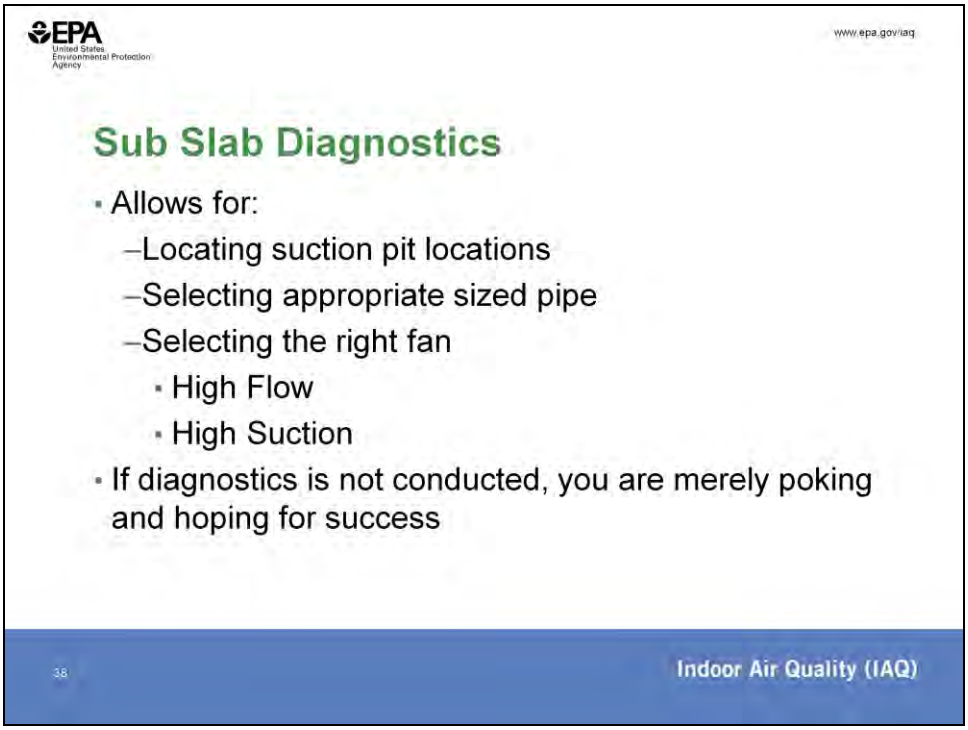
So, how does this active soil depressurization work? Well, the principle of it starts with what we call diagnostics. On the left hand side of your screen, you see a small port in the upper left hand corner along with the vacuum cleaner hose that's attached to a one to two inch hole through the concrete floor.

On the right hand side is a digital micromanometer. It's a digital device that measures pressure differences between one area to another. In this case, we're measuring the pressure difference achieved between the sub-slab area and the room itself. So, when we turn that vacuum cleaner on, we should be sucking air from underneath the bed of the floor and we should be able to measure that, then with the micromanometer on the right hand side.

It measures in either pascals or inches of water column. For this PowerPoint, pascal is the unit we're going to be using. The diagnostics tell us where the air is moving under the slab, if there's any sub-slab areas that may be connected to one another. For instance is there a void space underneath a shared common wall for instance. It also tells us so much negative pressure can be achieved from one point to another. And it allows us to determine the pressure field extension.

Pressure field extension is a fancy term for determining how much influence or airflow and pressure we have underneath a concrete floor.

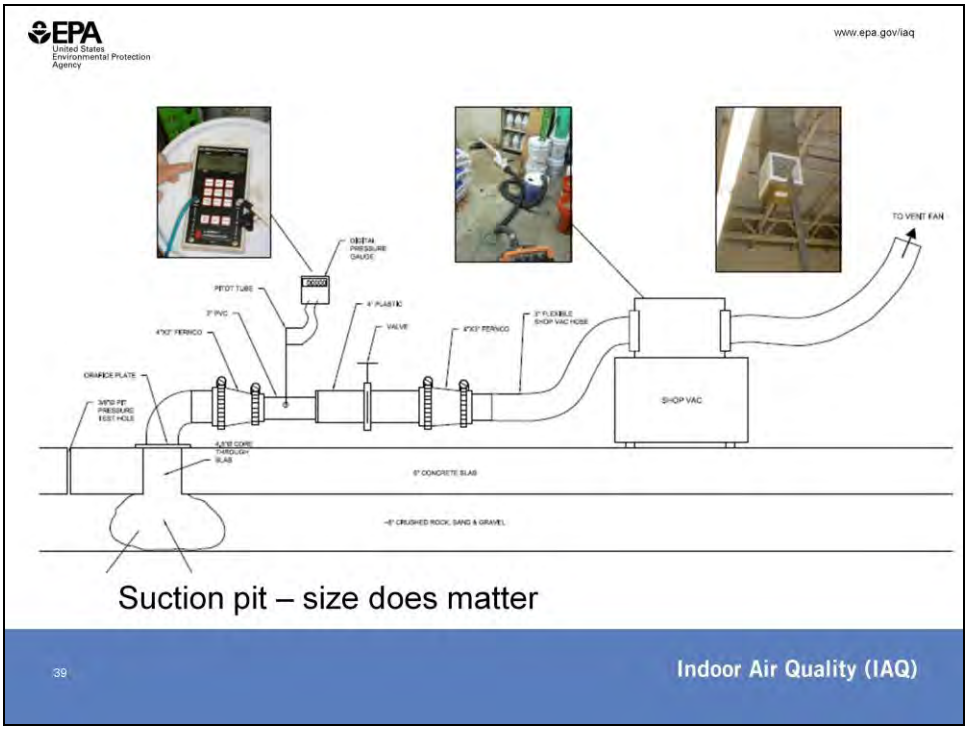
Next slide.



So, diagnostics allow us to locate our suction points. Select the appropriate size pipe as well as the appropriate size fan, and is that fan going to be a high airflow or a high suction fan? Well, you won't know walking into the school until you do diagnostics on exactly what kind of fan you're going to need.

If you don't conduct diagnostics, you're merely poking a hole in the concrete floor and hoping for success. It's not recommended obviously. Going back, a high flow fan would be necessary in areas where we have, say, porous soils. Clean gravel fill is one example of an area where we're going to be looking for high flows – for a high flow radon fan.

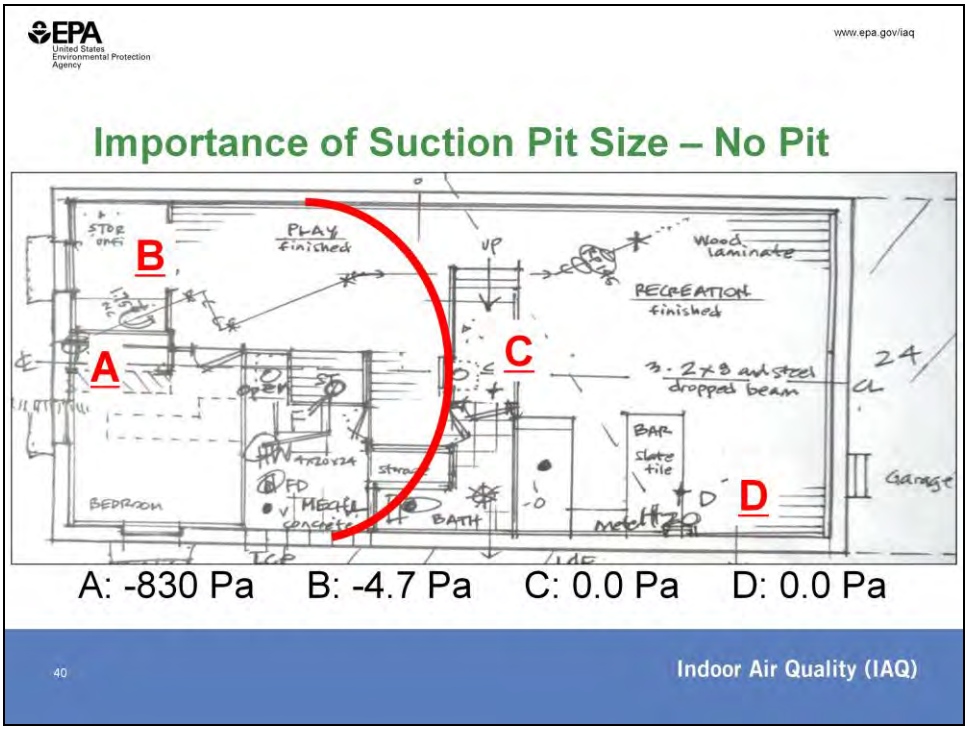
Conversely, high suction fans could be used in areas where we have tight soils such as clay or wet sand. Next slide please.



This is a diagram of a more sophisticated diagnostic setup, but it gets the point across. So, on the left hand side, you'll see kind of a balloon thing in the lower left. That's our suction point dug out underneath the basement floor. So, in this case, I believe we have a four or a six inch concrete slab and on top of that, we have a series of pipes and hoses connected to each other – connected to a shopvac, that's either vented to a vent fan blowing out of the building or vented to the outdoors which would likely be a better idea.

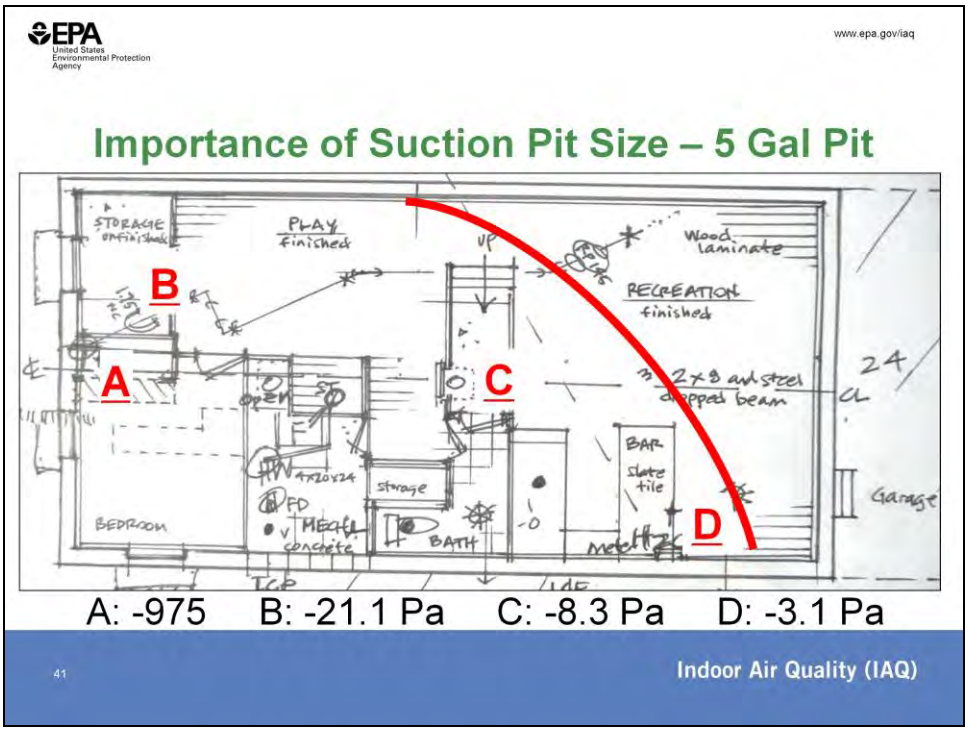
When we turn on that shopvac, we're now sucking air from underneath the basement floor. We can then through diagnostic test points, which is the one on the far, far left, we can measure the pressure change between the room and the soil below. In this particular setup, we can actually determine airflow as well – airflow going through the system that helps us determine – I should back up. The amount of airflow going through the system, compared to the pressure we're achieving, allows us to figure out what size fan and what size pipes could be used for this particular part.

The point on the bottom in there is the suction pit. The size really does matter. And here's a series of slides coming up to illustrate that point. Next slide.

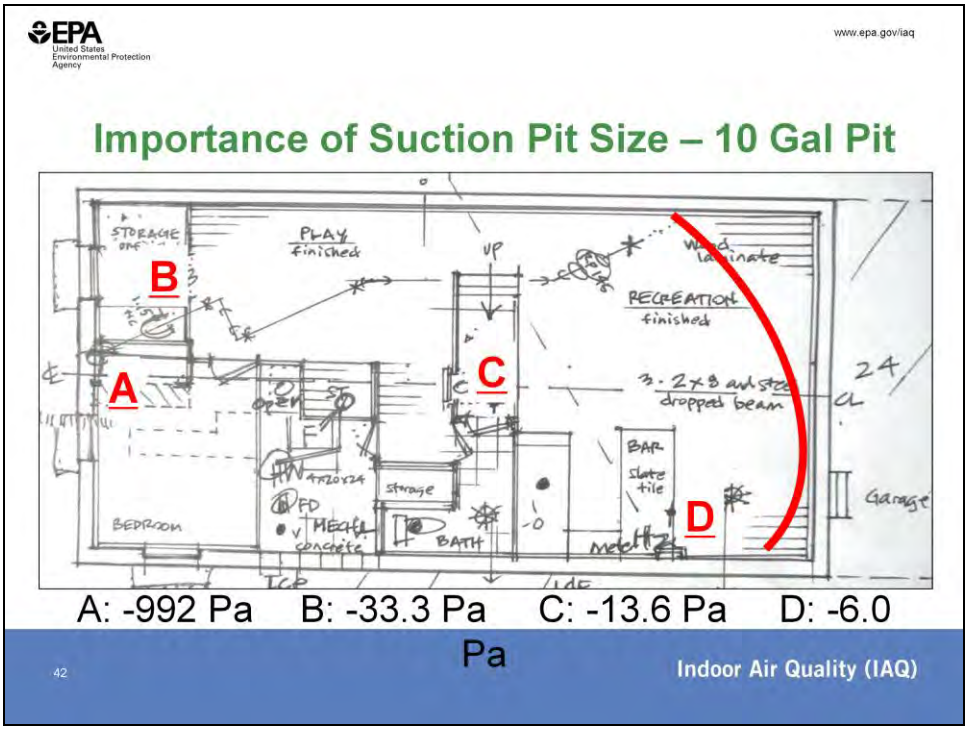


This is a residential picture. It's just a house with a rectangular basement, but the principles here are all the same. So, on Point A on the far left, we drilled a hole through the floor and we put our vacuum wand in there and we turn on the vacuum to achieve negative pressure under the floor.

That half-moon red line indicates how far our pressure field extension got without any suction pit dug. The amount of pascals is measured or shown at the bottom. We achieved pressure field extension to Point B which is not terribly far away from our suction point at A. And notice we only got maybe a third to half of the foundation covered. We saw no change in pressure at C and no change in pressure at D.



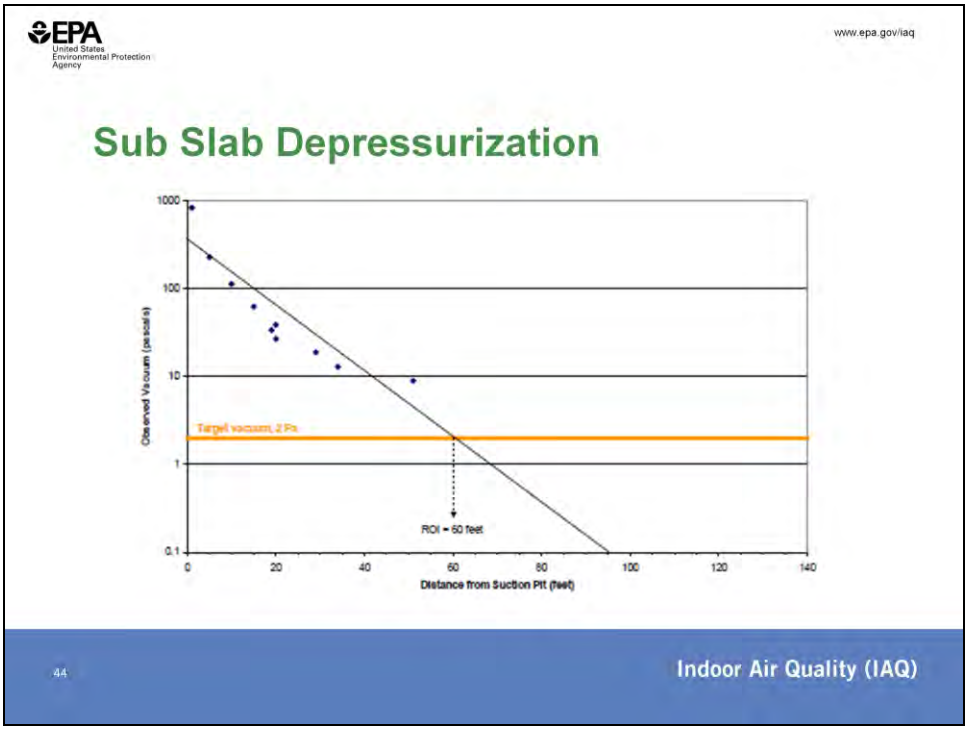
However, when we dig a bigger pit on the next slide, we see that we're simply taking off five gallons of fill, we achieve better pressure field extension. We tripled, if not better, our pressure field to B. We extended to C and we even got a little bit of a wiggle of pressure way far away, about 30 feet away at Point D.



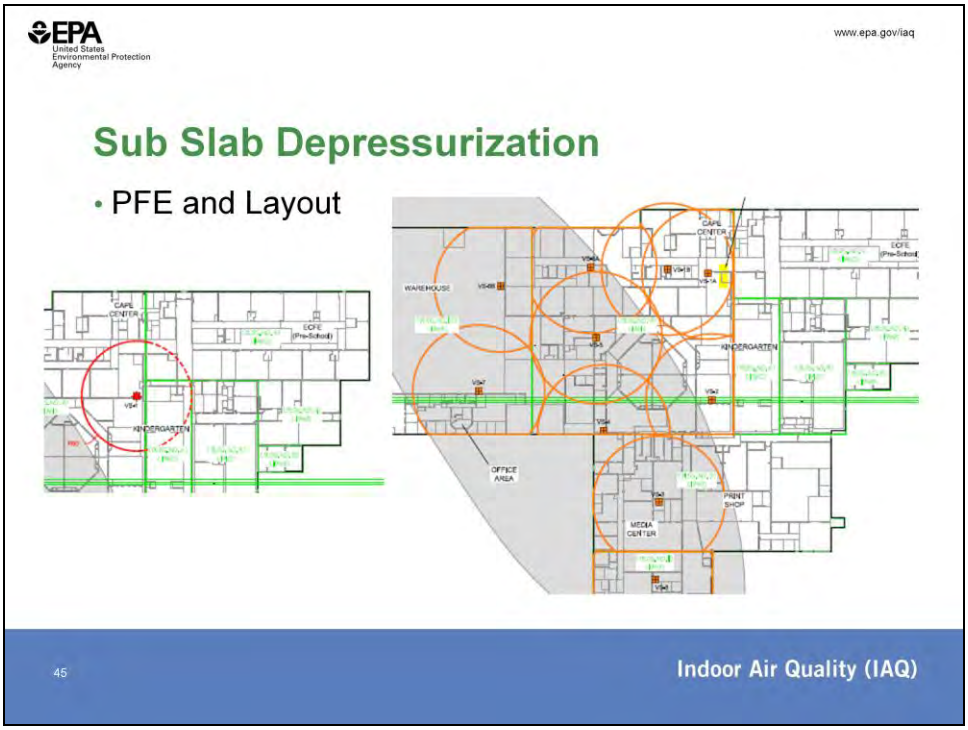
If we then dig an even bigger pit, double the size of the pit on the next slide, we show that we now have basically the entire basement foundation incorporated from one suction point. We now doubled essentially the pressure field or the pressure difference in all three of the different diagnostic test point areas.

So, the larger you can dig a pit, the better pressure field extension will be achieved. This can ultimately lead to fewer suction points and fewer vent stacks running through your building. Next slide.

One note on sealing. There's a common misnomer out there that if you have cracks and holes in your floors in the foundations where you have contact with the soil, you can simply seal it and the radon can no longer enter. Time and time again, that's been proven to be untrue. Sealing is not a stand-alone technique. But sealing in conjunction with an active soil depressurization will give you better pressure field extension, and a much more effective radon mitigation system. Next slide please.

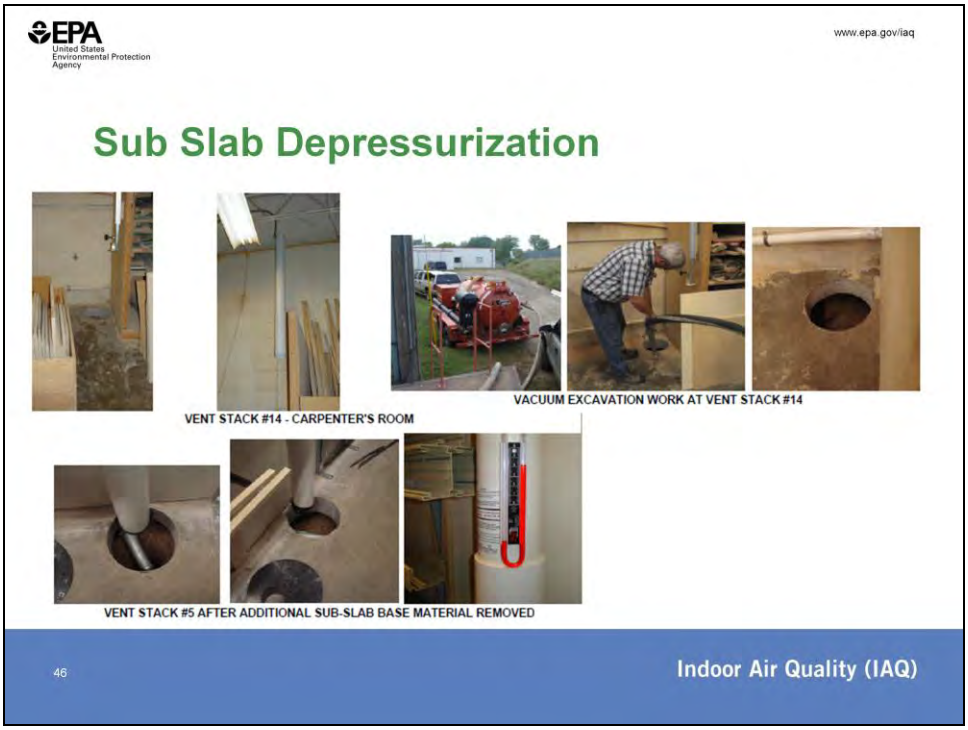


This is simply a log chart showing the relationship between distance from a suction point and the observed pressure variation in pascals. When you map it out in this particular case, the targeted vacuum pressure that we needed was two pascals in the school building, and that's pretty uniform for many of the schools we go into. If we can suck more than two pascals to our radon systems at the far corners of our pressure field, we should achieve good radon reduction. So we needed to map out our two Pascal pressure field map. Next slide.



This is a little bit of confusing so let me explain it upfront. On the left hand side, you have a map of an entire school. The left hand picture should really be on the far right. So, you have kind of this T-shaped school. But it doesn't come to play too much in this. The shaded area is actually where there was a vapor intrusion issue, but in this example, I'm going to use that grey shaded area as highlighting the areas where the radon levels have been high in classrooms. So, we need to mitigate the areas that are shaded.

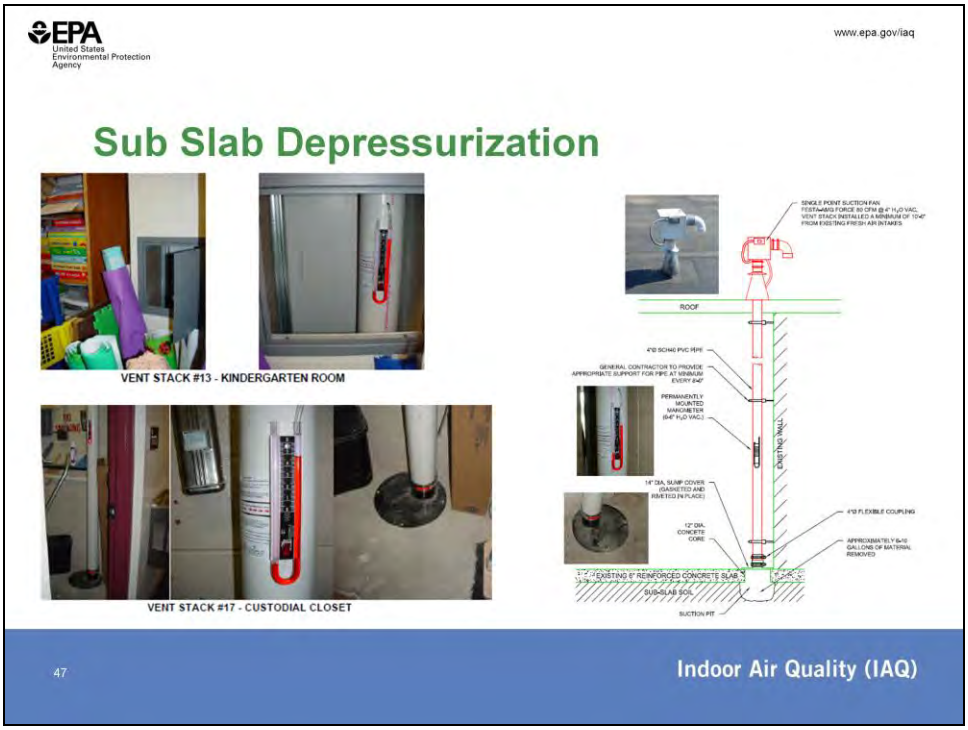
So, notice we don't have any radius or radii in the non-shaded areas solely. We went in and mapped the floor doing our pressure field extension and determined where we're going to put our suction point locations to take care of the soil gas that's underneath the building. Again, we're only going to put these where we need them. Next slide please.



Here are some photos from the field and what can be expected and kind of some of the steps in the process. In the far left picture on the top is a cord-suction point. That's actually a 12-inch hole. You can kind of make it out where we're going to put one of our radon suction points. And then the next picture is a vent riser that's running up through the roof.

The three pictures on the upper right are actually a photo of the process of a gentleman excavating or digging the suction point with a pump truck which is, in my opinion, a little excessive. But I guess if you have the tools, you might as well use them. You can also dig these by hand with just a shovel or some other hand tools. That's often what we do at homes. It's just a little shovel – a garden shovel and some scrapers.

On the lower left, you see a vent pipe going into an oversized suction point so we can actually dig a suction pit better. And then finally, the far right picture on the bottom is a picture of a U-tube. It's the final system pressure gauge. It's important to note that this is not a radon gauge, this is a pressure gauge. Next slide.



On the upper left hand corner, you see a view port for a hidden system. It's a radon system that's actually installed inside a wall cavity, so as to keep it out of sight. And then there's the U-tube manometer in there, and that's just the pressure gauge that school staff needs to keep an eye on just to make sure that the fan is operating.

When the systems are installed right, they're going to be quiet and they're going to be out of the way. So, if you're not looking for a radon system, you may not find it. So, if you don't hear a fan running, you can at least look at this U-shaped gauge to determine whether or not the fan is operating.

On the bottom is a finished suction point as well as the finished U-tube manometer reading. And also note that the U-tube pressure gauge is going to be different for every different radon system that we install because every system is actually unique to its building.

On the far right is one consultant schematic for a radon mitigation system, pretty straightforward. You have the suction pit at the bottom, you have a vent riser running up through the roof which is attached to a fan. Next slide.

A couple of other examples, on the far upper left is a digital pressure gauge. This is more of a true gauge. This will give you a hard number. It's called the magnehelic manometer. Someone could just keep an eye on it periodically.

The second picture in the lower left actually shows a roof penetration and multiple suction points being tied together into one roof penetration. So, just because we have, say, six suction points, doesn't mean we have six radon fans. We may have two fans. We may have four fans. We may have one fan. The middle photo is simply a radon fan toward the bottom there. It's kind of an egg-shaped bulge in the discharge. And then a condensation bypass on the top. And the fourth, this one on the final right, is just your typical six inch vent riser or an eight inch vent riser that's running through the finished floor and then up into a draft ceiling prior to it being boxed in with some final construction. Next slide.

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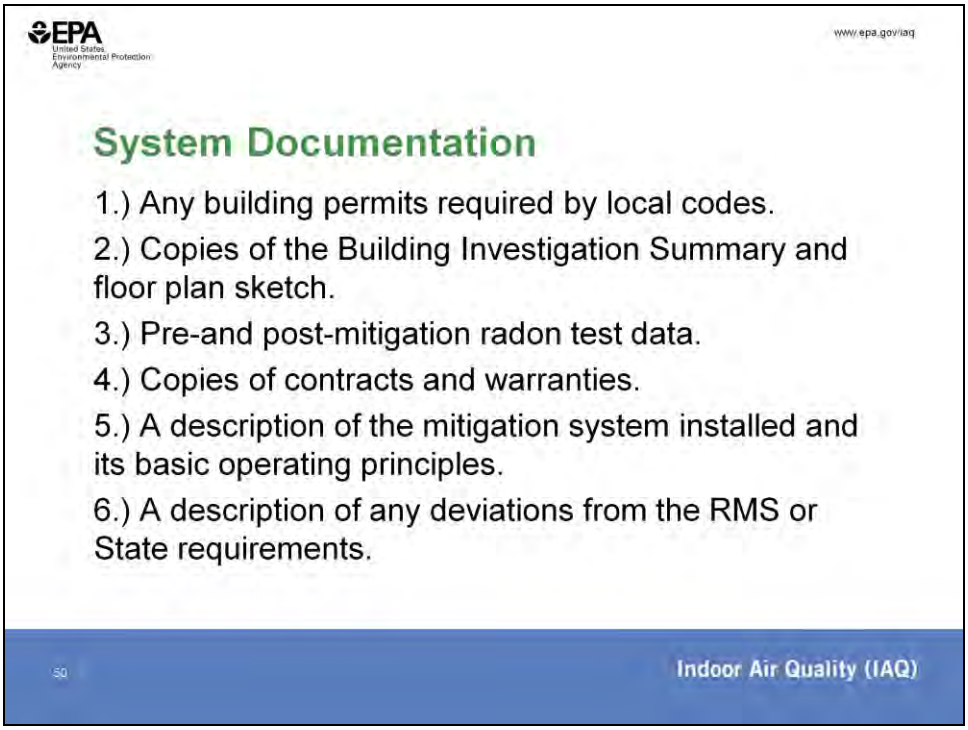
Sub Slab Depressurization

- Electrical Install

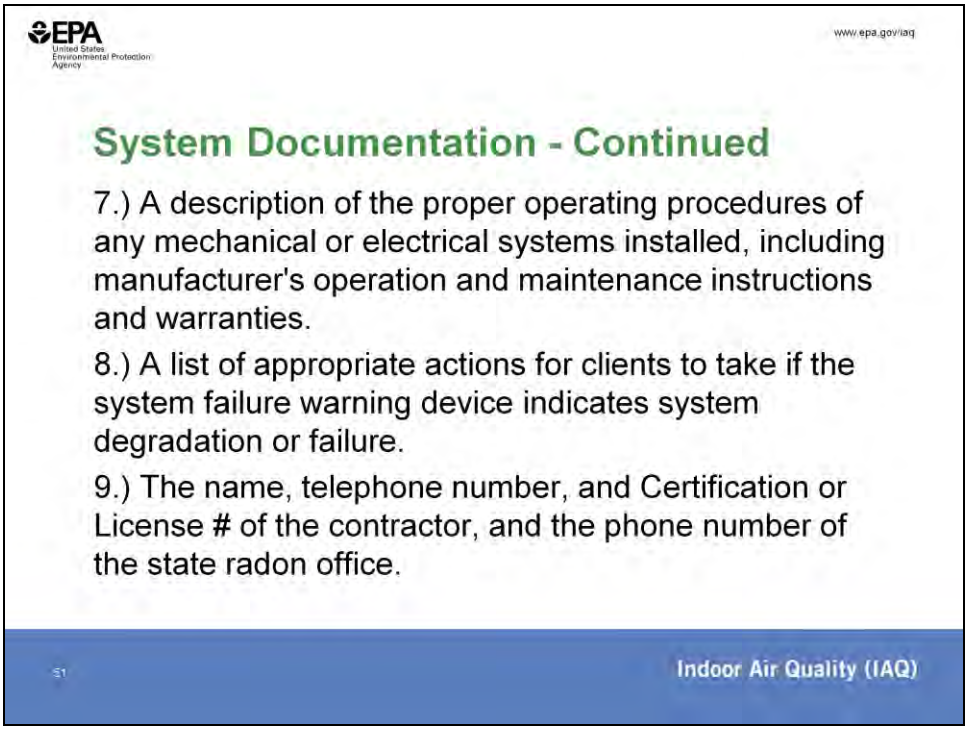
SUB-SLAB VENT SYSTEM FAN SWITCH

SUB-SLAB VENT SYSTEM FANS THROUGHOUT PORTION OF BUILDING

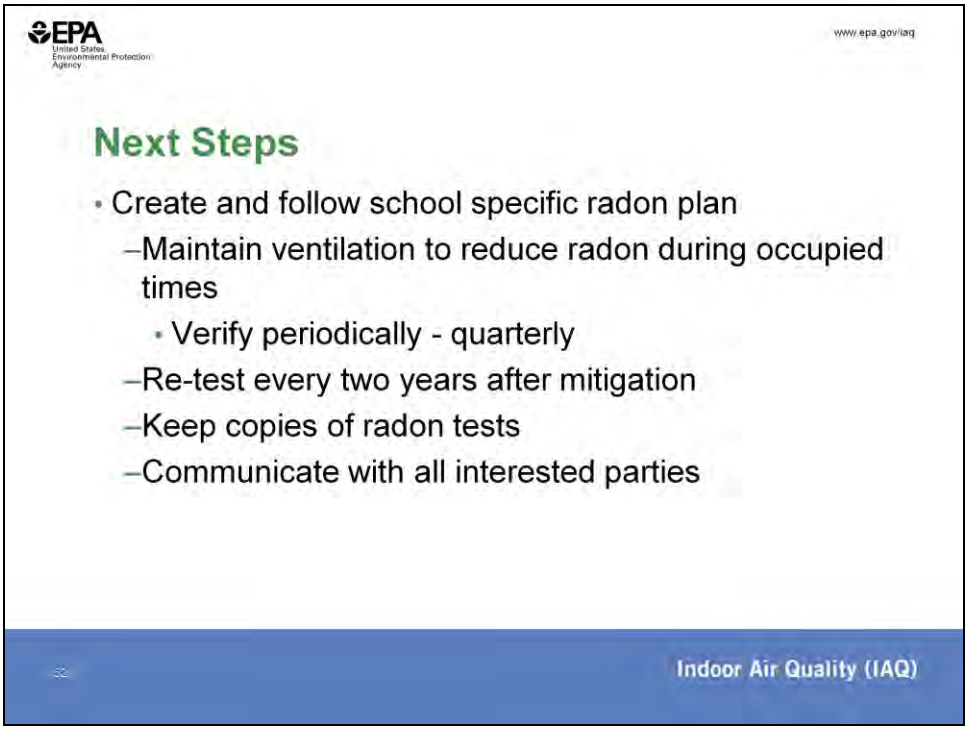
These systems do need an electrical disconnect for future servicing. Unfortunately, the fan at some point will fail, as all other mechanical systems do. Most fans in radon – radon fans I should say, you're going to have a ten to 12 year life on most of them. And then, in that bottom picture on the far right, you see exhaust and to the left of that exhaust, it's actually this particular vent system's fan. So, there's really not a whole lot of the system to see when you're on the roof. Next slide.



OK, once all is said and done, and these series of pipes and fans are connected and turned on, and we've done some follow-up radon testing, again, we're only going to test the areas that are of real concern, you're going to get a system documentation package from your contractor. And it's going to have to include all of this stuff. And I'm not going to read it all to you, but the short of it is, permits and maps, the pre-mitigation and post-mitigation radon test results, a description of how the system is used. Next slide.

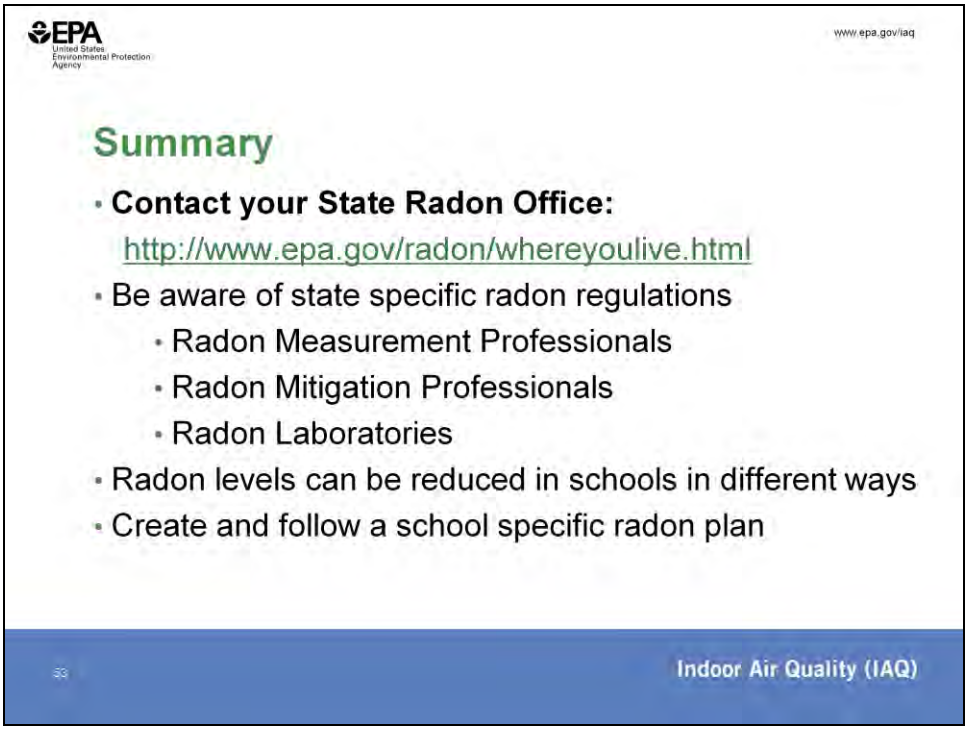


A description of how the procedures and electrical systems are used, any appropriate actions that the school should take if the system does fail. Usually, this includes calling the contractor or in our case, the State Radon Program because it's easier to get a hold of us. And then finally, the name and the number of the contractor as well as either the certification or the license number of the contractor, as well as the phone number for the state radon office. Next slide please.



So, the next steps are to create follow-up school specific radon plans. It's much easier said than done, and we're not going to get into it in this discussion. But the school folks are going to need to maintain the ventilation to reduce radon during occupied times. And this varies periodically. Personally, I'd like to see it kind of maintained or at least observed quarterly, but the instant you put someone in the classroom and it's just a little too cold because it's getting too much ventilation, and that school staff, say, puts a cardboard pizza box in one of the returns to block the airflow, well, now your entire system is kind of messed up. So, you need to evaluate that on a periodic basis.

If you do radon mitigation, whether it's ventilation control or sub-slab depressurization, the requirements – or I should say recommendation is to retest for radon every two years. Keep copies of your radon test results and communicate pretty much throughout the entire process with all interested parties. No one likes to be kept in the dark about what's going on. And when we run into issues with very worried parents or staff, we find that just educating them on radon is, the health effects, and the fact it's a long-term health concern and we're dealing with it now, that usually eases most if not all of their concerns. Next slide. Thank you.

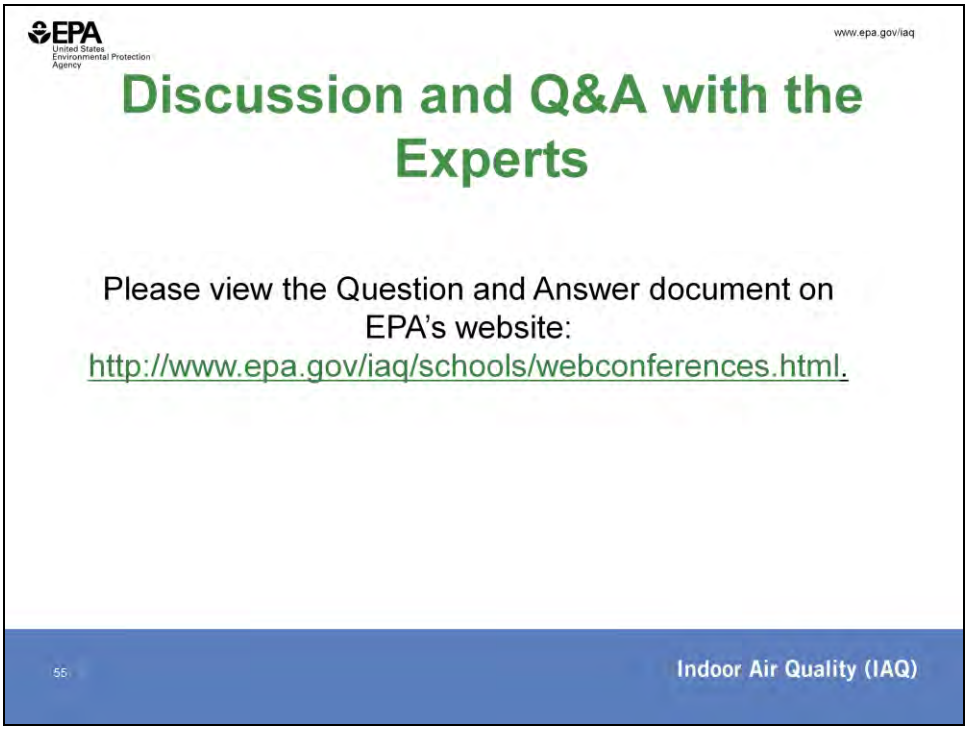


So, in summary, radon testing mitigation in schools really starts with a phone call to your state radon office. You can find it there at that website. You do need to be aware of state specific laws and regulations regarding radon. Radon can be reduced in schools in a few different ways, and create and follow a school specific radon plan. That is redundant. That is redundant for a reason.

Keep in mind that any reduction measures are only as good as the maintenance of those reduction measures. One big, big opponent of radon in schools is deferred maintenance. If we can stop deferred maintenance, we can stop a lot of radon problems in schools. Next slide.

Here's our two contact infos. If you get a hold of us at the Minnesota Department of Health, and just ask for Josh, either one of us can really answer your questions but emails are probably the best way to get a hold of either one of us.

So, with that, we will turn it back to EPA.



Lou Witt:

Thank you. Thank you, Josh and thank you, Josh. What we'd like to do now is talk a little bit about the resources that we have available for you, and we'll show you some slides on that in a minute. And then we'll take some questions from the audience. We had a few earlier that came in while the presentation was going on. All right, one came in. Josh, either Josh on this one. One came in and asked, what do you use to seal cracks with?

Joshua Miller:

Sealing cracks in concrete, you have a couple of different options. I shy away from silicone because silicone is only temporary permanent. I prefer, it's kind of a nasty stuff, but I prefer urethane-based caulks which lasts nearly a lifetime of the building. You can also use expanding grouts or expanding cements. Hydraulic cement is one that we use routinely. Oh, and as well as expanding spray foam but use it in the appropriate place.

Lou Witt:

OK. Thank you for that. One other question came in. Could you explain the stack on the roof? And I think they're referring to the vent stack.

Joshua Miller:

The second vent on the roof in particular, that's the brainchild of a local radon contractor. The exhaust is offset to control some of the condensation or precipitation that may fall into that vent stack. He says that it gives him longer fan life. Now, that's only anecdotal evidence and it was really the best picture that I had to show the radon vent stack going through the roof a building. To bring it to a residential side of things, we rarely in Minnesota use those condensation offsets at all. We just vent it straight through, so it looks like nothing more than like a plumbing stack. But if you do have larger vent pipe, you might have things falling in it. So, precautions should be taken to ensure that the fan runs all the time and it isn't blocked by something.

Lou Witt:

Once a school has been tested and found that there are no spaces above four, is there any reason to retest that building in the future, even if no changes has been made to it?

Joshua Miller:

Yes. In general, our recommendation has been every five years to retest or during any building change. Just because there was no remodeling or no changing HVAC equipment doesn't mean that the building wasn't moving in those five years or that the HVAC system may have lost a damper along the way. There are a lot of different things that can go wrong in the HVAC system especially that can cause radon levels to vary greatly through the years.

Lou Witt:

OK. Well, another question for Josh or Josh. Are you allowed to have a fan in the attic or does it have to go outside?

Joshua Miller:

It needs to be in an unconditioned space. In general, schools don't have attics. A lot of times, the attics of schools are actually a return plenum for the whole HVAC system. And both of our examples there, the fan is on the roof because it's only place where it's actually in a ventilated space to the outdoors. Because what can happen if the fan is released or some bushing comes lose, we could be, you know, sucking out a few thousand picocuries and especially if it's in the return plenum, which could be their attic or in a crawl space, you know, and are pumping thousand picocuries into the building and distributing it around for everyone.

Joshua Kerber:

And unfortunately, we may never know that.

Lou Witt:

All right, another question. Is there a recommended minimum horsepower

vacuum to use?

Joshua Miller:

No, horsepower's bad to judge on because as Kerber went through, you really have to know if you need flow or if you need suction. They're two completely different types of fans, but they also have the same horsepower rating. So, you really have to look at the combination of required CFM to pressure. Essentially, you have to look at the different fan curves of each fan to match up where your predicted specs are going to be on the fan and if it can actually handle it.

Lou Witt:

And another question came in. Do you get a lot of questions about using HEPA or carbon filters to reduce radon levels?

Joshua Miller:

No, we don't get a lot of questions about it. I think a lot of the reason is people don't know a ton about radon to understand that filtering may or may not make an effect on it. Filtering's not the solution for radon, and if you do have really high radon levels, you'd actually be creating some other problems inadvertently that you don't want to deal with.

Lou Witt:

Ok, any other questions from our audience? OK, here's one that came in. Only one classroom in a building is identified as being high, do you install a mitigation system to only that classroom or install various systems throughout that building?

Joshua Miller:

Well, the deal with radon reduction or radon mitigation systems is that we're only going to attack the classrooms that need to be fixed. So, if you have just one classroom that's shown to be a problem, we're going to focus our efforts on that classroom, and that classroom only.

And some schools have just taken the stance whether it's just one room in a basement or one office that's in a locker room, or if the maintenance room becomes high - a lot of times their mitigation plan is actually just to move people out of that room and utilize a different part of the building, which is fully acceptable too as long as they have that in their documented plan.

Lou Witt:

OK. What's the correct way to pronounce picocurie? I think it's picocurie.

Joshua Miller:

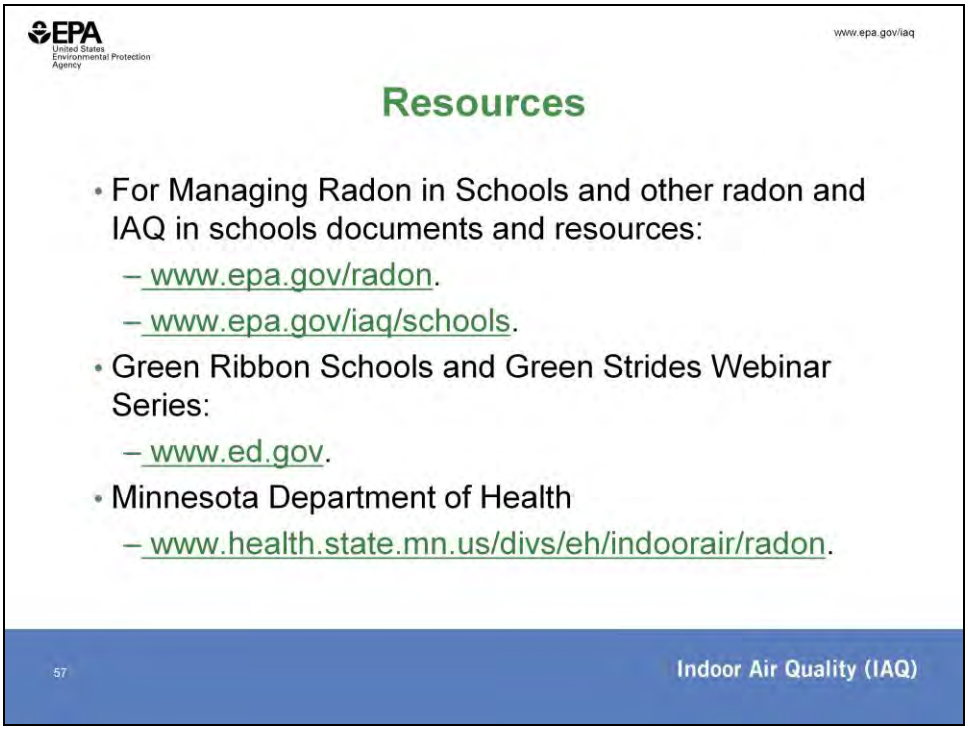
I'll go with what you said. Tomato – tomato, really.

Lou Witt:

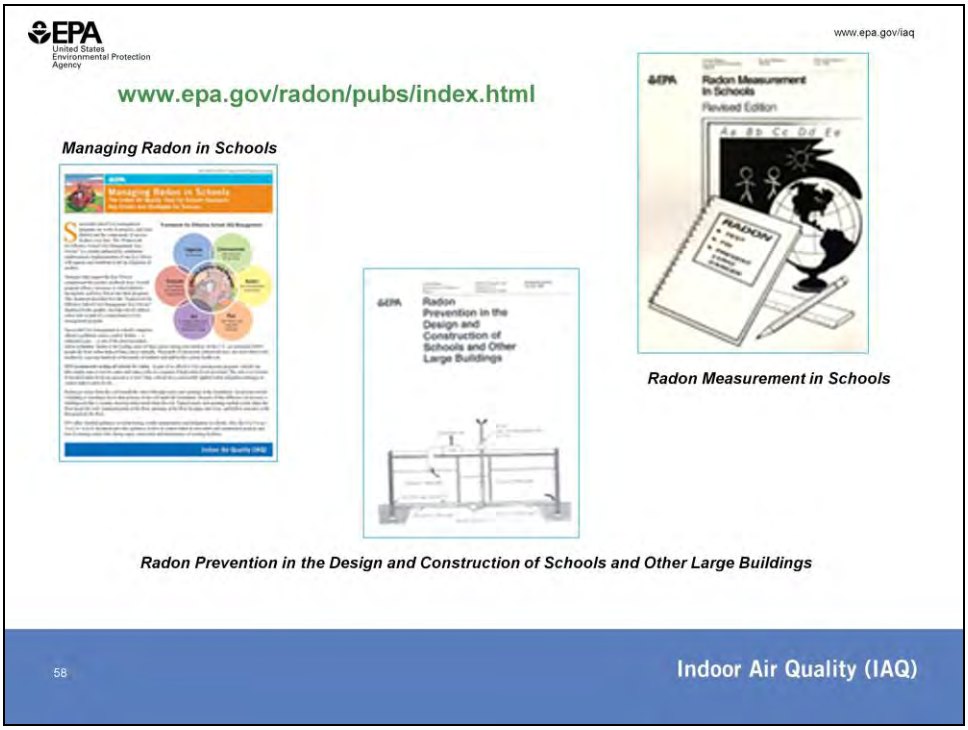
I have heard it pronounced Pico – I think it is Pico though.

OK, well any other questions, please contact our presenters or contact Jani Palmer or myself at EPA. We'll give you our contact information in just a minute, but for all the questions that did come in and the answers that we were provided, we'll post those to our EPA website. We'll show you that URL in just a second. OK, there it is. Give us a week or two, a couple of weeks, and we'll have the slides up. We'll have the audio up. There'll be 508 compliant. We'll have a list of the questions and answers more than likely pulled together by that time also.

As I've said at the very beginning, a lot of this is geared towards applying for the Green Ribbon Schools award and you can visit that website and get more information on that and I hope you certainly do.



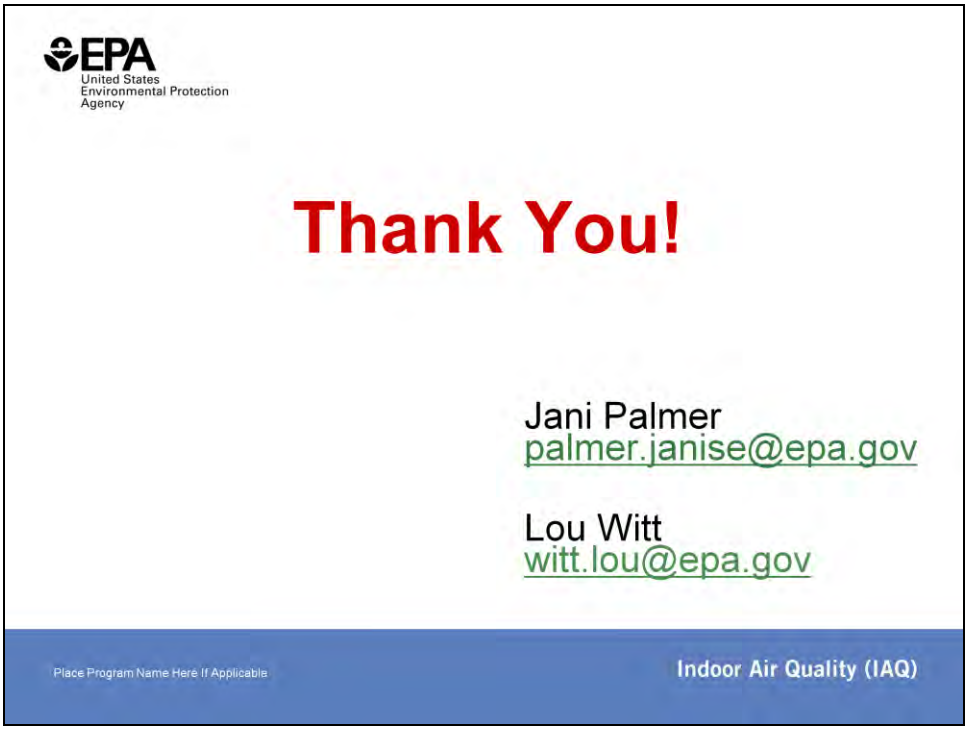
As you go about working on your schools to test or to mitigate, please consider the resources that EPA and the State of Minnesota make available to you. Some of our documents are a little bit dated, but the information is still valid. The protocols are still valid as Josh said earlier. We're working on some new standards for radon testing and mitigation at schools, but until that becomes available, what we have is still good and then certainly usable. So, please consider these three websites. I guess there are four websites as some primary resources for you.



So, please consider these three websites. I guess there are four websites as some primary resources for you.

Upcoming Webinars

Please view EPA's *IAQ Tools for Schools* website for upcoming webinars: http://www.epa.gov/iaq/schools/.



So, in conclusion, I'd like to thank all the people that signed up today. As I said, please go to our website. If you have questions, contact Jani Palmer, contact me. I know Josh and Josh are both always willing and open to discuss the technical and the problematic aspects of this, so please make yourselves known and we'll be in touch at the next webinar.

So, thank you very much. Thank you, Joshes. I sure appreciate it.